Vol. 54 No. 1 July 1960

Quarterly

of the

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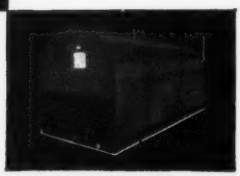

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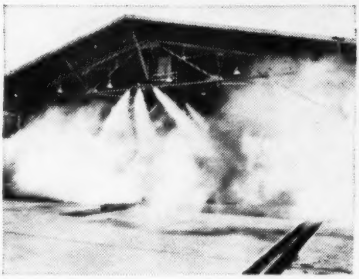

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Vol. 54 No. 1 July 1960

Quarterly

The Standard Technical Journal of Fire Protection for More Than Fifty Years

The NFPA is a nonprofit technical and educational organization devoted to the reduction of loss of life and property by fire with a total membership of nearly 18,000. The QUARTERLY is one of the publications regularly provided to members. Other membership publications include *Fire News*, *Advance Reports* to the Annual Meeting, a *Year Book*, and many leaflets, pamphlets, and posters issued throughout the year on fire prevention and control. Seven volumes of the National Fire Codes are available on an annual subscription basis, one volume free and others at reduced membership rates. For full details on available material ask for a free list of "Publications on Fire Prevention and Protection."

NFPA annual dues are $15.00 for Associate Membership of which $6.00 is for subscription to this Journal. National and regional societies or associations may apply for an organization membership for which annual dues are $100; such a membership entitles four individuals to receive the periodical membership publications.

Technical committees of the Association develop means to safeguard life and property through the publication of standards covering all phases of fire prevention and protection. Your membership in the Association affords an opportunity to keep abreast of these developments, and, by being a member, you help support this humanitarian activity. Popular educational literature on fire safety is constantly being produced by the NFPA for distribution through its members to the general public.

National Fire Protection Association

International

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Printed in U.S.A.

Newly elected as the 33rd President of the National Fire Protection Association, Mr. Loren S. Bush is Chief Engineer of the Pacific Fire Rating Bureau, San Francisco. Mr. Bush is the first NFPA President from west of Chicago. His appointment brings long overdue recognition to his personal contribution nationwide to fire protection engineering and to the Pacific Coast activity in our field which has been outstanding for many years.

Quarterly

of the

NATIONAL FIRE PROTECTION ASSOCIATION

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Articles and accounts of fires appearing in the Quarterly are based on material forwarded to the Association. The Association, as a body, does not assume responsibility for the accuracy of the material printed herein.

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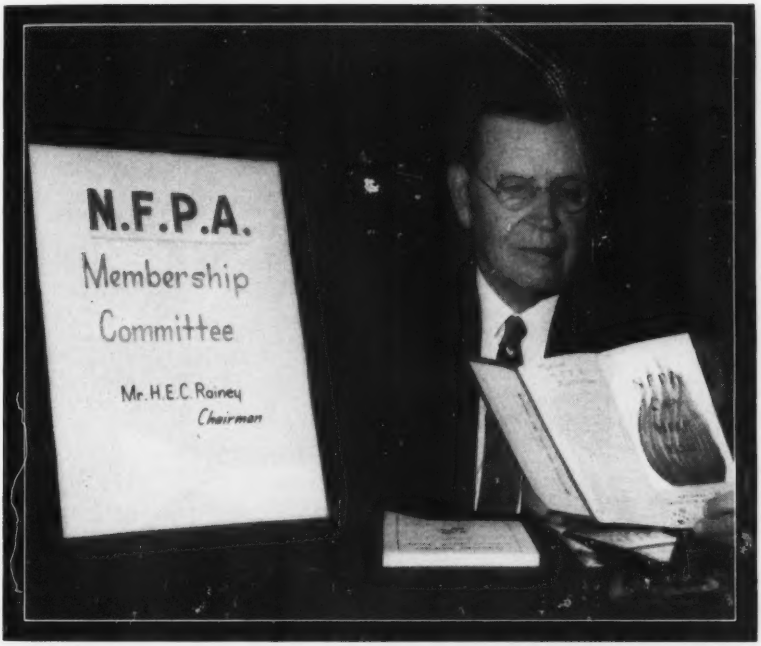


H. E. C. Rainey

Died July 7, 1960

Honorary life member and beloved chairman of our Membership Committee, H. E. C. Rainey, died in Bourne, Massachusetts, on July 7, 1960.

Mr. Rainey's years of devoted service to NFPA are well known to most of our members. In 1938, while Manager of the Insurance Rating Bureau of the District of Columbia, he accepted the post of Chairman of the Membership Committee of NFPA. Upon his retirement, a few years later, he agreed to continue his service to NFPA on a full time basis, and he continued that service without interruption up to the time of his death. During this twenty-two-year period, our membership has grown from 4,200 to nearly 18,000. His services were recognized in 1953 by his election as an Honorary Life Member. Mr. Rainey's great contribution to the growth and influence of our Association will long be remembered. It is with a deep sense of loss that we record his passing.

Daily Monitor-Leader, Mt. Clemens, Mich.

The tragedy of dwelling fires is that the innocent young, such as the seven-weeks-old boy in this crib, are the predominating victims.

Large Loss of Life Fires of 1959

An NFPA Fire Record Department Study

During 1959 there were 53 fires in the United States and Canada causing at least six fatalities each. A total of four hundred and forty-one (441) persons died in these fires. In this article these 53 loss of life fire disasters are analyzed and reported so that their lessons may be publicized and applied.

The factors responsible for these disasters are believed to be the same as those responsible for most of the 11,300 United States and the 520 Canadian fire fatalities that occurred in 1959. Thus application of the lessons taught so painfully by large loss of life fires will cause a major reduction in the disgraceful annual records of fire fatalities of these two countries. In fact, the application of these lessons is the only practical way to make a substantial reduction of loss of life fires.

Statistical Summary

Of the 53 fires causing six or more deaths, six resulted in 12 or more fatalities.

Sixty-four per cent (282) of the 441 victims of large life loss fires died in building fires. The remaining thirty-six per cent died in other "nonbuilding" fires. Of the 159 "nonbuilding" fatalities, 146 died in transportation fires, 7 died fighting fires, and 6 died in a mine fire.

Forty-seven of the large loss of life fires causing 402 deaths were located in the United States; the remaining six fires, responsible for 39 deaths, occurred in Canada.

The following table shows the number of people killed and the number of large loss of life fires by occupancy classification.

	Number Killed	Number of Fires
Residential	239	33
Transportation	146	14
Institutional	38	3
Industrial	6	1
Outside	6	1
Underground	6	1
Total	441	53

Definition of "Large Loss of Life"

For the purposes of this study a large loss of life fire is one in which 6 or more persons died in a single fire or explosion. For this year's study, six fatalities were chosen arbitrarily as a starting place for a proposed annual analysis on this subject. For the purposes of this study individuals are classified as *children* if they are 15 years of age or less and *adults* if they are 16 or over.

Acknowledgment

The credit for this story is due to the efforts of many people: to NFPA members who have voluntarily sent notice of these fires to fire chiefs and city fire marshals who have reported the facts and figures on these fires, often at the cost of additional time and effort on their part; to the state fire marshals and other state and government officials who have spent time checking records to see that the list is as complete as possible and who themselves have produced needed facts for the analysis. Without this help and interest there would have been no story.

It is hoped to make this study on "large loss of life fires" an annual feature of the QUARTERLY. Your help in gathering information of this type is earnestly solicited. Send reports to the NFPA office, Fire Record Department, 60 Batterymarch St., Boston 10, Mass.

1959 Large Loss of Life Fires —

In Residential Properties

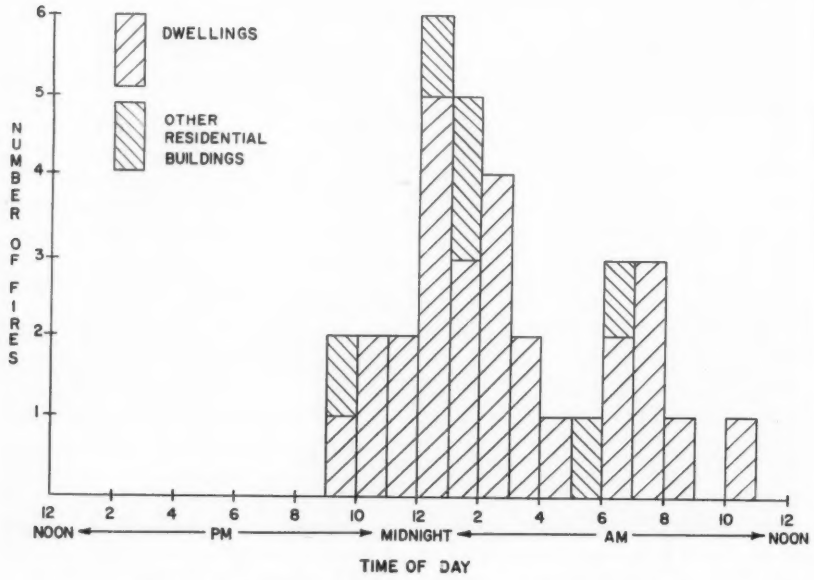
There were 239 persons killed in the 33 large loss of life fires in residential properties during 1959. The following list gives the occupancy classification, number of fires, and number killed.

	Number Killed	Number of Fires
Dwellings	195	27
Apartments	24	3
Hotels	13	2
Dormitories	7	1
Total	239	33

Time of Fire

One of the most interesting facts to come out of this study is illustrated by Graph I, Number of Residential Large Loss of Life Fires by Hour. All residential fires costing 6 or more lives each occurred between 9 P.M. and 9 A.M. except for the gas explosion at 10:20 A.M. in Clear Lake Shores, Texas. During this 12-hour period the number of fires reached a peak just after midnight, a low point between 4 A.M. and 6 A.M., then a spurt as persons rose to get their homes going for the day.

It is important to note that during the 12-hour period when most of these large loss of life residential fires occur, the occupants are usually home and asleep, a condition that frequently results in delayed detection of a fire.



Graph I. Number of Residential Large Loss of Life Fires by Hour.

Floor of Death

Table I shows the floor on which the occupants received their fatal injuries.

Table I

Location of Victims When Fatal Injuries Occurred

Floor	Number Killed: Total Residential	Dwellings	Other Residential Buildings
Basement	7	7	0
First floor	133	125	8
Second floor or above	99	63	36
Total	239	195	44

The fact that 133 of the persons died from injuries received on the first floor where the escape should have been fairly easy is significant. This indicates that a person can be trapped on the first floor of his residence, if he does not have warning of the fire in time to move out of available exits.

Dwellings

One hundred and ninety-five of the 441 fire deaths reported in this study occurred in dwellings. This is 44.2 per cent of the deaths analyzed. In the over-all picture of fire deaths, the NFPA has estimated that approximately 5,600 of the 11,300 fire deaths in the U. S. in 1959 occurred in dwellings. This is about 49.5 per cent. Thus it would appear that this study of multiple death tragedies reflects closely the national distribution of fire deaths by occupancy.

Factors Responsible for These Deaths

The factors which are primarily responsible for these deaths are listed in Table II. The principal reason for the loss of life was that people were trapped by the fire either before they could attempt escape or before they could reach the exits safely. This *trapping* accounted for 176 (90.3 per cent) of the dwelling deaths. Of these 176 that were trapped the largest part were trapped because

Table II

Factors Responsible for Loss of Life in the 27 Dwelling Fires Analyzed

	Primary Factors: No. Killed	Per Cent	Secondary Factors*: No. Killed	Per Cent
Trapped by Fire in Dwelling	176	90.3	274	100.0
Occupants asleep, discovery delayed	77	39.5	61	22.2
Gas explosions or flammable liquid flash fires	41	21.0	8	2.9
Inadequate exits	35	18.0	89	32.5
Open stairways blocked escape from upper stories	13	6.7	51	18.6
Combustible interior finish caused rapid fire spread	9	4.6	64	23.4
Occupants awake, discovery delayed	1	0.5	1	0.4
Children Left Unattended	14	7.2	0	0
Re-entered or Remained in Burning Dwelling to Attempt Rescue	3	1.5	0	0
Individuals Intoxicated	2	1.0	0	0
Total	195	100.0	274	100.0

*Note—Several secondary factors were found in some fires. Thus the total of secondary factors exceeds the total primary factors.

they were asleep. They either never awoke or they had no opportunity to escape by the time they finally did awake. Of those awake, however, only one was trapped by delayed discovery.

Explosions of gas or of vapors from the misuse of flammable liquids was the second most common cause responsible for trapping of the occupants. The third most common cause of trapped people was the absence of adequate exits or exit routes. Another common cause of blocked escape or trapping occurred when flames or smoke spread up open stairways. And finally, rapid flamespread over combustible interior finish cut off exit routes for the remainder of the trapped victims.

Most of the 19 victims not "trapped" were children who had been left alone by their parents and were not able to escape once the fire had started.

Note from Table III that the urban and rural homes visited by these tragedies are almost evenly divided although it is obvious that multistoried dwellings are peculiar problems for the urban habitant while the single story dwelling is no guarantee against loss of life by fire, particularly in rural areas.

Table III

Location and Height of Dwellings Where Large Loss of Life Occurred

Total Height of Dwelling	Total	Urban	Rural
Basement only	1	0	1
One story	15	5	10
Two story	10	8	2
Three story	1	1	0
	27	14	13

Room of Origin

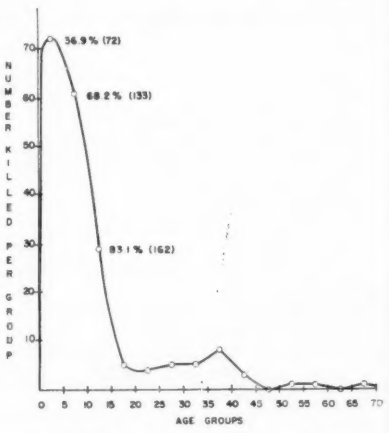
Table IV lists the room of origin of the fire where known and the number killed by the fires starting in these rooms. Fires starting in the living room and the kitchen were the main "killer" fires accounting for two-thirds of the total number of fires. Living room fires killed 76 (39 per cent) of the victims. This undoubtedly reflects the fact that living room fires often smolder undetected in upholstered furniture for long periods. The lack of detection is due most often to the fact that the occupants have already gone to bed.

Table IV

Where Large Loss of Life Dwelling Fires Started

Room	No. of Fires	No. Killed By These Fires
Living Room	11	76
Kitchen	7	45
Bedroom	2	14
Hall	2	13
Basement	1	7
Closet	1	7
Other or No Data	3	33
Total	27	195

In the NFPA Occupancy Fire Record on One- and Two-Family Dwellings (FR 56–2), living rooms and kitchens are listed as being the most frequent



Graph II. Dwelling Large Loss of Life by Age Group Showing Cumulative Percentage and Number under Age 14.

Table V

Large Loss of Life Dwelling Fire Deaths by Cause of Fire

	Killed		Fires	
	Number	Per Cent	Number	Per Cent
Heating or Cooking Equipment	96	49.2	13	48.2
Wood or coal stove	36		4	
Chimney or flues	19		3	
Wood or coal stove, flammable liquids used to "freshen" fires	21		3	
Oil-fired heater or stove	13		2	
Combustibles near stoves	7		1	
Smoking or Matches	27	13.8	4	14.8
Gas Explosions	12	6.2	2	7.4
Rubbish (ignition source unknown)	6	3.1	1	3.7
Incendiary (deliberate)	7	3.6	1	3.7
Electrical Wiring or Equipment	6	3.1	1	3.7
Defective Kerosene Lamp Explosion	6	3.1	1	3.7
Undetermined	35	17.9	4	14.8
Total	195	100.0	27	100.0

rooms of fire origin considering fires of all types and seriousness.

Age of Victims

Graph II illustrates the tremendous toll these large loss of life dwelling fires take of the young. Those under age 14 accounted for 83.1 per cent of the fatalities, with those under four making up an incredible 36.9 per cent (72). Those between five and nine accounted for 31.3 per cent (61) and those ten to fourteen for 14.9 per cent (29).

Causes

Table V gives the causes of the fatal fires by number along with the number killed by these fires. Fires connected with heating and cooking equipment caused 49.2 per cent of the deaths and 48.2 per cent of the fires. Smoking fires accounted for 13.8 per cent of the deaths and 14.8 per cent of the fires. Gas explosions killed 6.2 per cent of the people causing 7.4 per cent of the fires.

While the fires caused by misused, overheated and defective cooking and heating equipment were evenly distributed over the time period shown in Graph I, the four smoking fires were grouped between 12:30 A.M. and 3:50 A.M. and two of the three "flammable liquid used to freshen fire" fires occurred between 6:30 A.M. and 7:30 A.M.

Reports of Dwelling Fires

Dwelling of Charles A. Kidwell
Vincennes, Ind., Jan. 1, 12:03 A.M.
6 Killed: 2 Adults, 4 Children

The street outside the 1-story Charles Kidwell residence had been dug up for a sewer. The gas service line to the Kidwell home had either been damaged by this construction or was defective. Portions of the house, unknown to the occupants, had filled with a combustible gas-air mixture.

While the older members of this family watched the New Year "in" on television, the small children slept. A minute or two

after midnight the eldest son rose from his chair in front of the television set and flicked the wheel of his new Christmas cigarette lighter. A flash fire resulted and the house was severely shaken by the ensuing explosion.

The mother (34) and her four daughters (13, 10, 3 and 2) were killed in their home but the father (41) and his three sons were able to escape although all were critically burned. The father died in the hospital, but the three boys recovered after long hospitalization resulting in hospital bills in the vicinity of $14,000.

Dwelling of Nora Smith
Winstonville, Miss., Jan. 5., 9:00 P.M.
6 Killed: 1 Adult, 5 Children

A mother poured kerosene on a kitchen coal-burning stove. Shortly thereafter, about 9:00 P.M., the stove exploded, spreading fire quickly through the one-story, frame dwelling. The 35-year-old mother was killed along with four of her children (14, 9, 8 and 5), and a grandchild, aged three. Two other children escaped but no explanation is available on how they were able to reach safety.

Dwelling of Mark Kelly
Brandon, Minn., Jan. 7, 2:25 A.M.
6 Killed: 1 Adult, 5 Children

A defective coal furnace and substandard combustible hot air ducts were responsible for a fire in this 2-story, wooden dwelling. Investigation indicated that wood used in the ducts ignited in the parents' bedroom on the first floor, presumably from the defective furnace. At 2:25 A.M. smoke awoke the parents who ran outside for help. Just after the door to the outside was opened, an explosion occurred, probably caused by ignition of the incomplete products of combustion distributed through the dwelling by the hot air ducts Fire spread up the open stairway to the second floor children's bedroom.

The father (38) re-entered the flaming building and died trying to rescue his children, 15, 14, 12, 10 and 3 years of age. The mother was kept from a smiliar fate by neighbors.

Dwelling of Booker T. Gardner
Boswell, Okla., Jan. 8, 2:30 A.M.
16 Killed: 1 Adult, 15 Children

The father left his 1-story 4-room home at sundown for an all-night raccoon hunt. His wife was left to care for 15 children, ten of whom were her own, three were orphaned nieces, and two were visiting nephews. During the early morning hours, a fire occurred, probably caused by an overfired and thus overheated wood-burning stove. All occupants were asphyxiated before neighbors were alerted by the sight of flames.

The mother had time to gather the children, but could not find a route of escape, as evidenced by the fact that 15 of the victims were found in one corner of the rear bedroom. One child's body was located outside the bedroom window where she appeared to have been pushed. The rear bedroom had no door to the outside. The children ranged in age from twins 6 weeks old to 15 years and 10 of the 15 were girls.

Dwelling of Horace Bradshaw
Lincoln Heights, Ohio, Jan., 11, 2:55 A.M.
7 Killed: 2 Adults, 5 Children

In order to improve the heating in one of the bedrooms of this 1-story home, the family had purchased a used oil-fired room heater. Whether they did not know how to operate it or whether it was defective will never be known for an explosion in it blocked the one exit door from the children's bedroom.

Fire fighters responding to a neighbor's call found the home heavily charged with smoke. The father's body (aged 35) was found on the floor near the rear door, and the mother's (aged 36) on the floor near the front door. The children (aged 9, 8, 5, 3 and 2 years) were found in their beds.

Dwelling of Robert Neal Oden, Jr.
Clear Lake Shores, Texas, Jan. 19, 10:20 A.M.
6 Killed: 2 Adults, 4 Children

The father and his entire family were killed in a gas explosion in a 1-story home they had occupied for just over 2 months. Open gas jets were found in the debris after the explosion leading to the supposition that the explosion might have been the result of foul play or suicide and murder. The father (39) had used at least 20 aliases and was wanted in several states and various cities for numerous criminal charges. The children were 7, 6, 4 and 2 years of age.

Dwelling of Luther Tripp
Ashland, Me., Jan. 20, 1:10 A.M.
6 Killed: All Children

Six children asleep in second story bedrooms were asphyxiated in their beds by fire that was out of control in the open stairway between the first and second stories when discovered at 1:10 A.M. by a boarder who

United Press International

A mysterious gas explosion killed an entire family in Clear Lake Shores, Texas, January 19.

slept on the first floor. His shouts aroused five of the 11 people asleep in the second story of the wooden dwelling in time for them to escape via a porch and a shed roof. A faulty flue opening in the chimney was thought to have allowed heat to escape and ignite the structure nearby and thus cause the fire. The oldest of the six young victims was a girl 15 years old; the others were 12, 9, 4, 3 and 2 years.

Dwelling of Amelia Parker
near South Bend, Ind., Feb. 14, 11:36 P.M.
7 Killed: 1 Adult, 6 Children

Ignition of wood piled under a wood-burning coal stove was the apparent cause of a fire in this cement block and wooden 1-story, 4-room home. At the time of the fire wood was being burned in the stove instead of coal. A grandmother (58), who was babysitting, succeeded in arousing one child, 6, who ran out of the house. She also had time to call the fire department (11:36 P.M.) just before flames, spreading quickly over a plywood ceiling, trapped her and the remaining 6 children (aged 10, 8, 5, 3, and 2 years and a baby, 6 months). A long fire department run of over 4 miles ruled out any chance for rescue by responding fire fighters.

United Press International

Dwelling of Sotero Rodriquez
Crystal City, Texas, Feb. 21, 10:10 P.M.
8 Killed: 1 Adult, 7 Children

An explosion of undetermined cause originated in the kitchen of this small 1-story wooden home killing the mother (aged 25) and her two oldest children (9 and 7 years) who were with her in the kitchen at the time. Neighbors, hearing the explosion, saw the house quickly enveloped in flames and drove to the nearest telephone to give the alarm. The other five children (aged 6, 4, 3, and 2 years and a baby, 7 months) were asphyxiated in their beds.

Dwelling of William Hrycuik
Batoche, Sask., March 5, 10:00 P.M.
7 Killed: 1 Adult, 6 Children

The parents of this family and their 6 children were living in the 18 ft. by 28 ft. basement of their unfinished home. The basement had only one exit and was heated by a wood-burning stove. The stove vent pipe ran directly out through the wooden ceiling since there was no chimney.

An older friend (aged 66) had arrived the previous day for a visit and the parents took this opportunity to go out together for a little while.

Evidently the visitor retired with the children since his body was found near his bed. The stove is believed to have overheated and ignited either the wall behind it or the ceiling above it. Even though heroic rescue attempts by the father succeeded in removing three of the children, they were already dead of asphyxia. The oldest child was 7 years, the youngest, 6 months.

Dwelling of Richard Pelch
Flint, Mich., March 7, 3:50 A.M.
6 Killed: 2 Adults, 4 Children

Four children and their parents were suffocated in bed by smoke from a smoldering fire in an upholstered chair in the living room of this 1-story, wooden 4-room dwelling. One of the parents had sat in the upholstered chair watching a television show and smoking before retiring. The parents (29 and 24 years old) slept on a studio couch in the living room, the children (aged 8, 7, 5 and 3) in the bedroom.

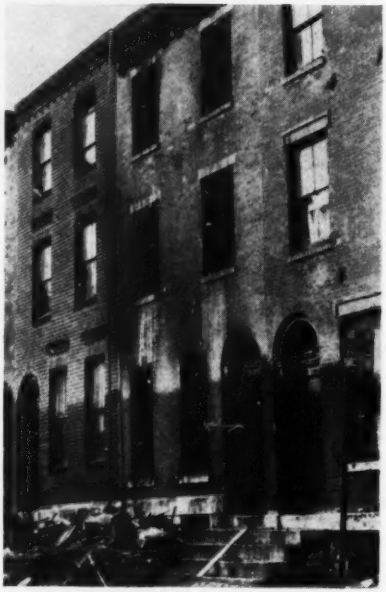
The fire was discovered by a neighbor at 3:50 A.M. who, awakened by the smell of smoke, called the fire department. The fire fighters removed the burning chair and extinguished the small fire in the flooring under the chair, but all the occupants were dead on their arrival.

Dwelling of John Hersey
Easton, Me., March 13, 1:45 A.M.
7 Killed: 2 Adults, 5 Children

A father, a guest, and 5 of six children living in this 1½ story, frame dwelling died in a fire that started at or near the coal stove in the living room. The stove fire had been "built-up" about an hour earlier when the occupants returned home through a blizzard then in progress. The mother, 40, and a daughter, 13, escaped by diving through a first floor window. The father, a fire fighter and professional boxer, 42 years old, had refused to leave with his wife, presumably in the hope he could rescue his other children (aged 12, 9, 6, 5 and 4).

The flames, smoke, and heat swept into the first floor bedroom and up open stairs to the upper bedrooms. The daughter who had escaped with her mother ran 100 feet through the blizzard to a neighbor's house to give the alarm. Fire equipment bogged down in the four-foot snow drifts and only a few pieces could get to the fire.

Dwelling of Cornell Johnson
Philadelphia, Pa., March 15, 2:11 A.M.
8 Killed: 2 Adults, 6 Children

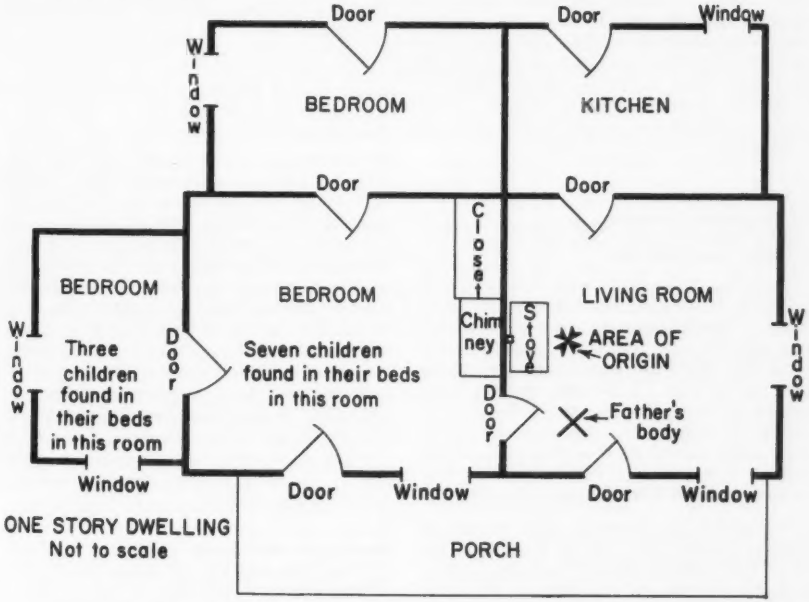


United Press International

Eight of the 10 children in the family that occupied this 3-story brick, wood-joisted dwelling lost their lives when flames swept up the open stair well from the first floor living room and trapped them in the second and third floor bedrooms.

The fire originated in an upholstered chair due to careless smoking. On discovering the fire in the living room, the father fought it with a quilt, then ran to a neighbor's, who in turn ran to a fire alarm box. The alarm

United Press International



This sketch and the photo above are of the dwelling of Daniel Byrd, Cross Hill, S. C. The original dwelling was a tenant farmer's home consisting of the two largest rooms. The kitchen and two smaller bedrooms were added later. Even though there were plenty of exits from the two major rooms, eight persons died there. The children's bodies were found in beds, and it is thought that they never awoke. **(See story on page 16.)**

was received at 2:11 A.M. In the meantime, the fire spread to the stairway.

The mother (38) managed to escape with two other children, a boy (17) and a girl (4), by leaping from an upstairs window. The mother was injured in her leap and was hospitalized. The oldest victim was 20; the others 19, 12, 8, 6, 4 and twins aged 1.

Dwelling of Daniel Byrd
Cross Hill, S. C., March 15, 1:00 A.M.
11 Killed: 1 Adult, 10 Children

A family of nine children and their parents lived in a three bedroom tenant farm house. On March 10, the mother took her 3-year-old child to the hospital for treatment of a heart ailment. She remained with the child.

The mother's sister came to keep the household operating. Two nieces, 13 and 8, also came. On the night of March 14 the father (aged 32) came home intoxicated. The sister left about 11:00 P.M. About 1:00 A.M., March 15, a neighbor ½ mile away saw flames leaping from the roof of the Byrd home. The burning house collapsed minutes after his arrival. It is thought that the father somehow accidentally started the fire at the wood stove. His body was located near the stove. Further details are not available. See diagram on page 15. The oldest child killed was age 13; the youngest, 6 months.

Dwelling of John O. Anderson
Superior, Wisc., March 16, 12:37 A.M.
6 Killed: 1 Adult, 5 Children

A father, who had been drinking, fell asleep in an overstuffed chair in his living room. The cigarette he was smoking fell into the chair. The chair smoldered for some time and then ignited. Flames spread to a nearby sofa. The smoke and fire gases spread up the open stairway of this 2-story wooden dwelling and gathered on the second floor asphyxiating his five sleeping children (aged 7, 6, 4, 3, and 2). The father (35) was burned to death in the living room chair.

It may have been over an hour before the fire was noticed by a neighbor who called for help. Fire fighters removed the burning chair and sofa, opened and smashed out windows in a vain attempt to rescue the children alive. The mother, who had been out, returned home while the house was being boarded up. She collapsed and was taken to the hospital for treatment of shock.

Dwelling of Edward Lewis
Danieltown, Va., March 29, 6:00 A.M.
7 Killed: All Children

Easter Sunday morning the parents awoke to find it slightly chilly. They built a fire in a small coal stove in the bedroom of this 1-story, wooden, 4-room dwelling, then dressed. Leaving the children, the husband drove his wife to church for the sunrise service and returned to his mother's home 200 yards down the road from his own house.

The damper on the coal stove had been left closed. The gases of incomplete combustion caused the stove to explode, blowing hot coals around the room igniting combustibles nearby. The unattended children (aged 11, 10, 8, 5, 3, and 2 years and a baby, 10 months) were asphyxiated in their beds.

A passerby saw the flames, attempted to call the fire department from a neighbor's telephone and, on discovering that the phone was out of order, drove 6 miles to the fire station to give the alarm.

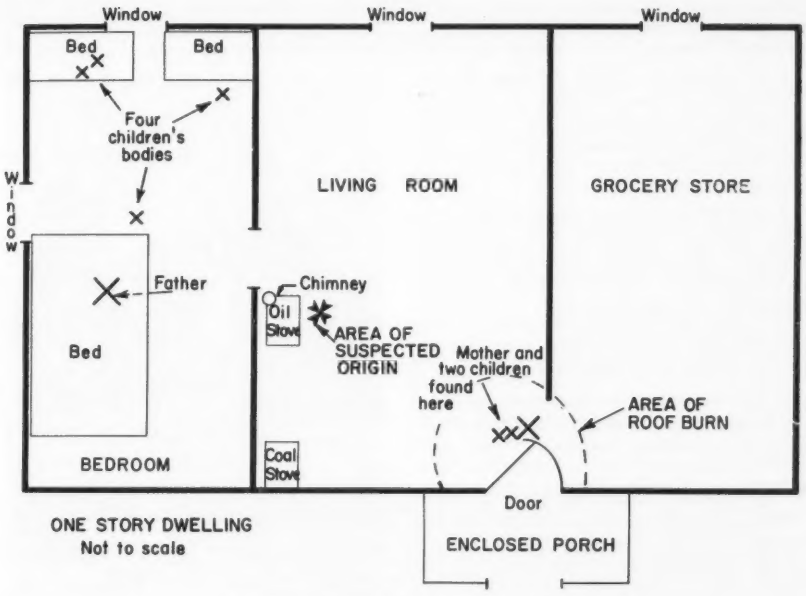
Rescue attempts by spectators were in vain due to the extent of the fire and by the time the fire fighters arrived, the roof had collapsed.

Dwelling of F. F. Waldrop
Hill City, Ga., April 25, 4:30 A.M.
6 Killed: 2 Adults, 4 Children

The mother of this family was in an out-of-town hospital undergoing surgery. The father had obtained a woman, 40, to stay with his five children. Also in the home was the father's stepsister, 20, and an eight-year-old friend of the children. The woman in charge may have been unfamiliar with the oil-fired heating device in the living room or the device may have been defective, details are not reported. It is known that an explosion occurred in the device and that the ensuing fire resulted in the death of the woman, the stepsister, and four of the five children of the Waldrops. One daughter, 7, and her visiting friend were in a rear bedroom of the 1-story dwelling and are reported to have escaped via a window.

Dwelling of Willie Nayakik
Barrow, Alaska, April 28, 7:25 A.M.
8 Killed: 2 Adults, 6 Children

This 15 ft. by 25 ft. wooden, 1-story dwelling contained a bedroom at one end, a living room in the middle and a small room used for a grocery store at the other end. There were no doors in the doorways between



The dwelling of Willie Nayakik, Barrow, Alaska.

rooms. The only exit from the home was through the front door located in the living room. In order to reach this door from the bedroom it was necessary for an occupant to pass close to both an oil-fired stove for cooking and a coal stove used to heat the building. This only exit was securely locked from the inside, presumably to prevent looting of the grocery store. There were two windows in the bedroom and one each in the other rooms. There was evidently no escape plan for the family in case of fire.

A fire of undetermined cause smoldered in the dwelling for an estimated twenty minutes. Neighbors were aroused when an explosion occurred about 7:25 A.M. and one of them ran 900 feet across the snowbanks to the school where the fire siren was located. Volunteers arrived with their pump cans to attempt control of the fire. Rescue attempts were thwarted by the locked front door.

Investigation after the fire and the position of the bodies indicated the following action of the dying occupants. The 34-year-old mother awoke first and smashed a window. Her escape by this route was evidently hampered by the fact that she was pregnant. Grabbing two of the children, she tried to escape through the front door but had to pass right by the oil heater and the coal stove. She died before she could unlock the door. The explosion may have been caused by the oil tank on the heater, or from the smoke buildup in the building getting oxygen from the broken window. In any case, two children were found in their beds, two on the floor near their beds, and the father under his bed. The parents were both in their thirties, and the children ranged from 1 to 10 years.

Dwelling of Roland Reid
Roddickton, Nfld., April 30, 7.30 A.M.
7 Killed: 2 Adults, 5 Children

An explosion and fire, believed caused when naphtha was used to light the kitchen stove, killed a mother (32), a daughter (16), and 5 of her other 10 children, ranging in age from 5 months to 11 years. Four children (aged 13, 9, 7 and 3) somehow escaped but details as to their routes and methods are not available. The father was at work at a logging camp.

Dwelling of Reginald Crowell
Detroit, Mich., June 14, 12:31 A.M.
7 Killed: All Children

In 1953, the six oldest children of this family had managed to escape a fire in their garage home in Cleveland, Ohio. They had been left unattended by their parents. The cause of the 1953 fire was attributed to children and matches.

Evidently, the parents did not learn their lesson for on June 14, 1959 at about 10 P.M. they went out again leaving their 8 children home unattended. At 12:31 A.M. a passing policeman in a patrol car saw fire in the 2-story house and radioed the alarm. It was estimated that the fire had been burning for 1½ to 2 hours when first reported.

The fire started in an upholstered couch in the largest front vestibule, and flames swept up the open stairway to the second floor hall partly entering some of the bedrooms where the children had been sleeping.

The youngest child (2) died in the fire, but the others (12, 9, 8, 6, 5 and 4) lived for a matter of hours before dying of their burns in a hospital. Only one of the children, a girl 11, survived although she suffered burns and abrasions from a leap from the second story.

Investigation indicated that the cause was probably a cigarette on the divan.

Dwelling of Robert Morse
Queen Charlotte Islands, B. C., June 27, 7:30 A.M.
6 Killed: 1 Adult, 5 Children

The flue pipe to a new oil stove in the kitchen of this 2-story dwelling overheated and ignited the combustible fiberboard wall covering nearby. It is inferred in the report that when the new stove was installed, the existing flue pipe was used; whether it was shifted closer to the fiberboard, whether the new stove produced higher flue temperatures or whether the ignition occurred after years of gradual charring could not be determined. The smoke and heat traveled up the open stairway that entered the kitchen, and the children asleep in their upstairs bedroom were asphyxiated.

A passerby ran into the building and managed to reach the second story before he was fatally overcome by smoke. Reports do not give the whereabouts of the parents at the time of the fire.

Dwelling of Michael Shusko
Elmira, N. Y., July 11, 11:10 P.M.
7 Killed: All Children

United Press International

A 15-year-old girl admitted setting three fires in her 2-story wooden home, the last of which took the lives of seven of her nine younger brothers and sisters (aged 12, 11, 9, 8, 6, 4 and 2).

On July 10 firemen had put out two small fires that had been set in second story bedrooms. The third fire was set about 11:10 P.M. in a first story clothing closet and spread through an open door at the foot of the stairs to the second story where the nine children slept.

By climbing to a porch roof, a neighbor was able to pull two of the nine children to safety. The children's mother had been sitting on the front porch while the fire was set. She was unaware of it until she heard a slight explosion (perhaps a can of food popping) and turned to find the house in flames.

Dwelling of Robert Langois
Mt. Clemens, Mich., July 13, 8:36 A.M.
6 Killed: 1 Adult, 5 Children

A fire of undetermined cause originated in the kitchen of this 2-story wooden house after the father had gone to work and the mother had returned upstairs. Feeding on the wooden kitchen finish the fire spread rapidly up the open stairway trapping the young mother and her four oldest children.

Three children (7 and twins 4) suffocated in their beds, while the mother sustained severe burns trying to rescue them before she and her oldest daughter leaped to the ground. The two youngest children (a son 7 weeks old and a daughter 3) in a first floor bedroom, were asphyxiated. The mother (26) was removed to the hospital where she died over a week later. The oldest daughter suffered a broken leg.

Dwelling of Terrence Currie
Havre Boucher, N. S., July 18, 3:00 A.M.
6 Killed: All Children

Fire, believed to have been caused by overloaded electrical wiring in the kitchen, spread up an open stairway to kill six of the seven children sleeping in the three second-story bedrooms of the six room, 22 ft. by 26 ft. home. One boy, 11, escaped by leaping from a second-story window. The parents, the oldest boy, and the baby asleep in the first-floor bedroom, escaped. The parents received burns requiring hospitalization.

The house was completely destroyed and the children's bodies so completely charred that identification was impossible. It is thought that the children, ranging in age from 3 to 10 years, died of asphyxiation before they were burned.

Daily Monitor-Leader, Mt. Clemens, Mich.

The dwelling of Robert Langois. **See also photo on page 6.**

Dwelling of C. King
Bauline, Nfld., July 19, 12:13 A.M.
6 Killed: All Children

The parents left their eight children in charge of the oldest, a 12-year-old girl, for the evening. This young lady decided to go across the street.

About 12:13 A.M., a kerosene lamp in one of the four rooms of the 1-story dwelling apparently started a fire. A 10-year-old son was able to escape with his life but was unable to rescue any of his brothers or sisters, aged 8, 7, 4, 3, and 2 years and a baby, 3 months.

Dwelling of Patricia Van Horne
Ottumwa, Iowa, Oct. 31, 12:45 A.M.
8 Killed: All Children

Combustible interior finish in the form of combustible fiberboard and plywood was responsible for the rapid spread of flames cutting off exit from this small 1-room, 1-exit, 1-story dwelling. The position of the bodies indicated that the 14-year-old baby sitter was able to retreat with the children to the kitchen area. Here the windows were partially blocked by a chest of drawers and a table. With no rear door they had no other exit.

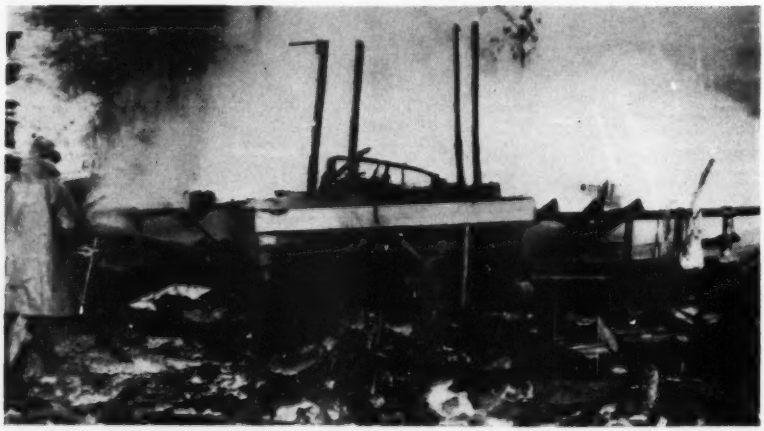
The fire, of undetermined cause, was discovered by the children's grandfather who lived across the street. In addition to the seven children asphyxiated in the blaze (aged 9, 7, 6, 4, 4, 2 and 1), the 14-year-old baby sitter died of body burns three days later. The children's mother was at a local tavern at the time of the fire. (See photo and diagram, page 21.)

Dwelling of Charles Harris
Jenkinsville, N. Y., Nov. 10, 6:30 A.M.
8 Killed: 2 Adults, 6 Children

Twenty-three years ago a 2-year-old boy had been burned in a fire which killed his mother, brother and sister. Now he was the father of a family of eight and was looking forward to moving them all into a new and bigger house on Wednesday, Nov. 11.

On Tuesday morning, Nov. 10, he awoke and went downstairs to the living room. The wood stove was cold. He piled on some fresh wood and poured in some kerosene to "quicken" the fire. After a minute, the kerosene, vaporizing from deep seated hot coals, had reached the explosive range and the old pot-bellied stove blew apart. The father was knocked from the house, his clothes ablaze, the mother (24) died of asphyxiation in the middle of the kitchen floor. The six children (ranging from 6 months to 6 years) were suffocated in their bedrooms by fire gases sweeping up the open stairway.

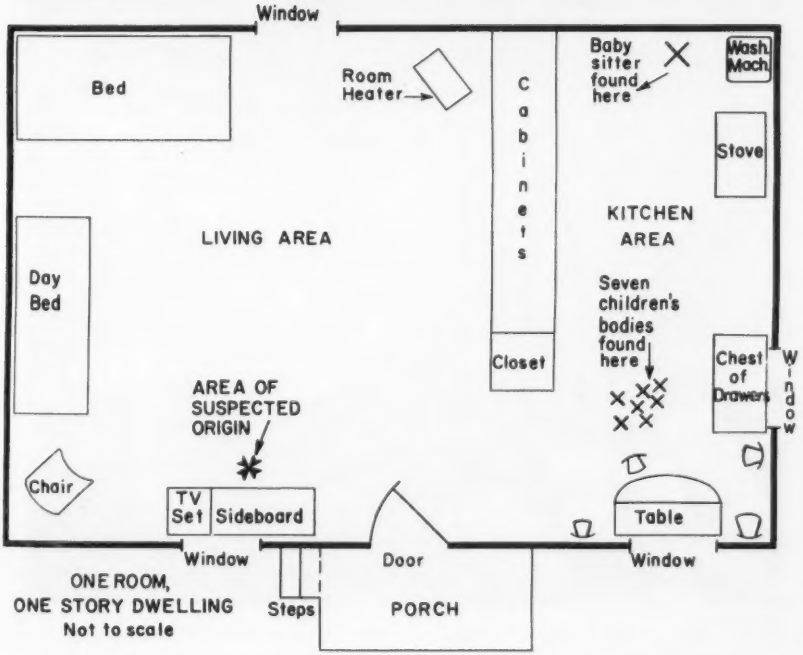
Neighbors, hearing the blast, notified the fire department and attempted rescue but the house was already completely involved. The father's burns were fatal and he died 5 hours later.



United Press International

The dwelling of Charles Harris — kerosene poured in the stove.

Ottumwa Fire Department



The dwelling of Patricia Van Horne, Ottumwa, Iowa, October 31, 1959. **See story on page 20.**

Apartments

There were three large loss of life apartment fires in 1959 resulting in the deaths of 24 persons.

Apartment of James McDonald
Rochester, N. Y., Jan. 1, 12:17 A.M.
6 Killed: 3 Adults, 3 Children

Six occupants of an upper story apartment quietly celebrating the arrival of the new year were trapped and asphyxiated by a fire that destroyed the third story and roof of the unsprinklered 3-story brick, wood-joisted building. The fire apparently started from an undetermined cause in a pile of old newspapers left on the second-floor landing of the rear and only stairway.

The alarm was given only 17 minutes after the new year had begun. By the time fire fighters arrived the flames had already swept up the stairway and into the third-floor apartment through the apartment doorway. The door had been left open. The only other means of escape was a ladder type fire escape which, for some reason, was not used.

Rescue attempts by fire fighters on the scene were hampered by incorrect directions

Wide World

A gas explosion killed 11 persons in this Ashland, Kentucky, apartment building. **See story on page 23.**

given by an occupant of a lower floor. Three adults in their 20's and three children, including one 2 and twins 5 months old, lost their lives.

Apartment and Mercantile Building
Ashland, Ky., Feb. 14, 1:00 A.M.
11 Killed: 7 Adults, 4 Children

Men worked in the second floor hall all evening to repair a gas stove they had removed from one of the apartments. It is not known whether these men were professionals or not, but they had forgotten to turn off the gas when they removed the stove. At 1:00 A.M. a gas explosion ripped through this partially occupied apartment building with fire following which quickly involved the only exitways. Occupants were forced to brave flames in the hall, jump from windows (where available), or wait for possible rescue in their apartments.

The alarm was given in error to the police department and this resulted in an estimated 10-minute delay before the fire department's arrival.

Twenty people were in the building at the time of the fire. Of the nine who escaped and lived, seven jumped from windows, sustaining injuries ranging from a broken spine to twisted ankles. Two were taken down fire department ladders.

Six of the victims were members of one family which lived in an interior apartment with no windows. As the flaming hall was the only escape route it is incredible that the pregnant mother of this family was able to reach a window in time to leap. The child she carried was delivered stillborn in the hospital shortly before the mother died. Other children who died were aged 4, 2 and 1 years.

The two stores on the first floor suffered mainly from smoke and water damage.

Apartment of Joseph White
St. John's, Nfld., Dec. 16, 6:55 A.M.
7 Killed: 2 Adults, 5 Children

Twenty-one persons were reported to have been living in this 30 ft. by 48 ft. 3-story concrete and wood tenement. At 6:55 A.M. a muffled explosion was heard in a section of the building occupied by one family. What happened cannot be definitely determined since the entire family — father, mother, mother's sister, 3 sons, and 1 daughter, were killed. It appears that a defective or mishandled oil-fueled kitchen range exploded but further information is not available.

Hotels

There were two hotel fires involving large loss of life in 1959 taking the lives of 13 persons.

Holleran Hotel
Lima, Ohio, Dec. 20, 9:24 P.M.
6 Killed: All Adults

This 3,000 sq. ft. 108-year-old, 2-story wooden hotel for old people and railroad pensioners contained (1) an open stairway, (2) combustible fiberboard ceilings and (3) locked rear exits on both floors. It was not sprinklered.

A 72-year-old resident saw the flames soon after they originated in a trash barrel which contained refuse for use in the lounge stove on the ground floor. The man yelled to another 50-year-old resident to escape out the front door. The latter, however, attempted to escape via a rear window but was unsuccessful as his body was found just inside the locked rear exit door.

The man who discovered the fire attempted to throw water on it but on finding the blaze too hot ran out the front door. One of the owners called the fire department, at 9:24 P.M.

Flamespread was so rapid over the combustible fiberboard ceilings that manual rescue attempts were useless. Five men ages 60, 67, 68, 73 and 89 died on the second floor, two in their beds, one on his bedroom floor and two on the hallway floor.

Gary Hotel
Hazleton, Pa., March 5, 1:10 A.M.
7 Killed: All Adults

Seven of the 61 guests in this unsprinklered 5-story brick, wood-joisted building lost their lives when fire swept through the 75-year-old structure. Ten others were injured.

The fire of undetermined cause originated at the base of the enclosed elevator shaft and was discovered by the night clerk at 1:10

Charles W. Catherman

The Gary Hotel in Hazleton, Pa., where 7 persons died after a 1:10 A.M. fire started at the base of an enclosed elevator shaft.

A.M. as he was returning in the elevator to the first floor after making a routine check of upper stories. He noticed smoke during the descent, and as he stepped into the lobby flames came up around the car.

Running upstairs, the clerk blew a police whistle to alert guests but was forced back after reaching the second story as smoke and heat rapidly entered the corridors from cracks around loose fitting elevator shaft doors.

Those who heard the whistle and acted promptly were able to make their ways to safety through the corridors to a rear fire escape and to an open stairway that went down around the elevator shaft. In a very short time, however, smoke and heat made corridors and stairs impassable and, before long, fire burning in partitions and above ceilings broke through the wood lath on plaster interior finish.

Several guests jumped to roofs of adjoining buildings and a few were taken down the fire department's two aerial ladders. Five victims died in their rooms, and two died in the hospital of severe burns within 48 hours of their rescue.

Dormitories

There was one 1959 large loss of life fire in a dormitory that killed 7 students.

Dormitory at Skytop, Syracuse University
Syracuse, N. Y., Jan. 6, 5:30 A.M.
7 Killed: All Students (Ages 18 to 29)

Seven military students lost their lives when an early morning fire spread through the building in which they slept. Of the 36 survivors, 16 were hospitalized.

The building consisted of what were originally two 150 ft. by 20 ft. wood-framed, aluminum-clad military barracks. These buildings had been joined to form an unsprinklered 150 ft. by 40 ft., one story structure. A central corridor had been constructed where the buildings joined and student rooms had been constructed on either side of the corridor. Combustible fiberboard had been used to construct the walls and ceiling of the corridor and the walls of the student rooms. It was also used for interior finish of the exterior walls and the sloping roof. Spaces between the fiberboard and metal walls and roof were filled with wood fiber insulation. The heater room, located in the approximate center of the building, was sheathed with ¾-inch gypsum wallboard.

The fire is believed to have originated about 5:30 A.M. where a metal chimney from an oil-fired heater went through the sloping roof of the heater room. High winds are thought to have blown the chimney from the center of the 12-inch thimble causing ignition of combustible insulation above the gypsum wallboard. From here the fire apparently spread through the insulation to an 18-inch-high concealed space above the fiberboard ceiling of the corridor, and came down through the ceiling into the corridor before occupants were awakened by smoke. With the corridor impassable, those who escaped did so by means of windows. Apparently the seven victims were asphyxiated before being awakened.

The building at one time had been protected by an automatic fire detection system. The system had been removed because the occupants had set it off so often with matches that it became a nuisance to maintain!

Wide World

Seven military students died in this dormitory fire at Syracuse University which spread over combustible fiberboard interior finish.

News-Press, Savannah

Aerial view of Meldrim, Georgia, freight train wreck showing burning trestle. Flames at right of two derailed box cars are coming from damaged LP-Gas tank cars. See story on pages 35-36.

Aerial view of Meldrim, Georgia, freight train wreck showing burning trestle. Flames at right of two derailed box cars are coming from damaged LP-Gas tank cars. See story on pages 35-36.

1959 Large Loss of Life Fires —

In Transportation Equipment

There were 14 large loss of life fires connected with transportation during 1959. These fires resulted in the deaths of 146 persons. The following list gives the number of incidents and deaths by mode of transportation.

	Number	Killed
Aircraft	5	42
Motor vehicles	6	65
Automobiles	2	13
Buses	2	28
Trucks	2	24
Ships	1	8
Trains	2	31
Total	14	146

The largest loss of life fire for the year in any category occurred in Meldrim, Georgia when a freight train left the tracks and LP-Gas, escaping from a damaged tank car, ignited, killing 23 picnickers in an adjacent picnic area. This and the other 1959 large loss of life transportation fires are reported below.

Aircraft Fires

There follow brief accounts of five aircraft accidents where six or more lives were lost as a result of fire aboard aircraft either in flight or at the time of ground impact. Forty-two persons died in these fires. One other accident, responsible for 34 deaths, was reported in the April 1960 NFPA QUARTERLY (page 415) but is not included here because subsequent investigation into the accident (and another crash involving the same type of aircraft) indicate that the basic cause of the mysterious tragedy was a combination of structural weakness in the wing (probably preceded by unusual stress or physical damage) and air turbulence in flight. While fire in flight did occur, it is now doubtful that it was the major cause for the loss of life.

U. S. Air Force Aircraft
near England Air Force Base, La., Jan. 22
6 Killed

A burning USAF KC-50 tanker aircraft crashed in flames shortly after take-off from the England Air Force Base. It was one of a group of six tanker planes just dispatched from the Base on an official mission. The pilot reported an emergency seconds after becoming airborne and advised he was going to return to the Air Base immediately. The plane crashed near a small residential community tearing down utility lines and scattering debris over a 200 yard area. All six crew members aboard died in the flaming wreckage.

NFPA efforts to get more complete information on the airborne fire through the usual Air Force channels have not been successful.

U. S. Marine Corps Aircraft
near Cherry Point, N. C., March 6
8 Killed

While attempting to make an instrument landing at the Marine Corps Air Station during a severe rain storm, an R4Q-2 transport plane crashed and burned with the loss of 8 of the 9 crew members aboard. Fuel tanks on the "flying boxcar" were ruptured as the aircraft hit trees during its descent, resulting in an airborne flash fire from ignition of the released vapors on the hot engine surfaces. When the plane hit the ground, the fuel tanks exploded and the eight who died were found in the fuselage having sustained very severe burns. The lone survivor was thrown clear of the burning wreckage. When rescue crews reached the scene 25 minutes later they found the survivor sitting on a tree stump

wrapped in his parachute trying to keep warm. The aircraft fire had largely died out as a result of consumption of the fuel and the heavy rains and only the fires involving magnesium remained.

Response of rescue crews was handicapped by swampy conditions barring crash equipment from the accident site which was 4½ miles from the approach end of the Air Station runway.

U. S. Navy Aircraft
near Whidbey Island Naval Air Station, Wash., May 11
9 Killed

During take-off, fire involved the right wing of a P2V-5 Neptune bomber. The pilot was unable to abort the take-off and the plane crashed just after becoming airborne. One crewman was pulled from the wreckage by crash crewmen but the other 9 aboard died in the burning wreckage.

NFPA efforts to get additional information from the Naval Air Station have not been successful.

U. S. Air Force Aircraft
near East Andover, N. H., July 22
7 Killed

An airborne explosion plus an explosion at time of ground impact was responsible for the seven deaths of the crew aboard this KC-97 tanker.

The aircraft came down in an open field but fog made it difficult to pinpoint the crash area which was 65 miles from the Air Base and 1700 feet off a side road between Andover and Concord, N. H.

The accident occurred at 1:44 A.M. and local fire departments reached the scene about 2 o'clock. The Air Base Fire Department was not advised until 3:25 and then they had to travel the 65 miles to reach the scene. Fortunately, the Air Base had conducted a school on handling such incidents for the civilian Fire Departments in the area and this training was of considerable value to the Andover Fire Department during this emergency.

The victims all received fatal burns but the evidence also indicates that the explosions were of sufficient force to inflict fatal injuries to the five crew members and two military passengers aboard the aircraft. No further information has been released on the cause of the initial airborne fire which was responsible for the ensuing crash.

Trans World Airlines Aircraft
Chicago, Ill., Nov. 24
12 Killed

Nine persons on the ground and the three crew members of a Trans World Airlines Constellation cargo plane perished when the aircraft faltered on take-off from Chicago's Midway Airport and struck a series of houses.

Tower-aircraft communications indicated the crew got "a fire bell on Number Two" engine and the pilot was attempting to bring the plane back to the airport when it struck the houses and started a severe fire in the built-up area surrounding the busiest airport in the United States. Whether an actual airborne engine fire existed or the alarm was a false indication has not been clearly established by the investigators.

The aircraft landed in a housing development, striking four homes and an apartment building while showering debris and flaming fuel over the area. The development was about three blocks short of the airport. Those on the ground who were killed were occupants of these dwellings many of whom were asleep when the cargo plane struck their homes at 5:35 A.M.

Zoning regulations around airports, particularly on approaches and extensions to the runways, have been too largely ignored in the U. S. The famed "Doolittle Report" of 1952 called attention to this fact but little has been done to follow the recommendations in this Report.

The year 1959 had a number of other air tragedies which are not included for the reasons indicated:

Other U. S. Aircraft Accidents

Crashes

Jan. 8, near Bristol, Tenn., DC-3, Southeast Airlines, 10 killed. Power-on collision with mountain probably responsible for the deaths although fire ensued.

Feb. 3, New York. N.Y., Electra, American Airlines, 65 killed. Crash into East River; no fire resulted.

Oct. 30, near Charlottesville, Va., DC-3, Piedmont Airlines, 26 killed. Crash not followed by fire.

Dec. 2, Montoursville, Pa., DC-3, Allegheny Airlines, 24 killed. Power-on collision with mountain probably responsible for the deaths although fire ensued.

Wide World

Note the concentration of dwellings and apartment houses directly off the end of the runway visible at upper right. The destruction in the foreground is where the TWA plane crashed on November 24, 1959, while attempting an emergency landing at Midway Airport, Chicago.

Flight Fires

May 12, near Chase, Md., Viscount, Capital Airlines, 31 killed. Fire followed disintegration in flight but structural failure judged basic cause of deaths.

Nov. 16, Gulf of Mexico, DC-7B, National Airlines, 42 killed. Explosion in flight with strong suspicion that a bomb had been placed aboard the aircraft and detonated maliciously in flight.

Overseas Aircraft Accidents

Overseas there were also a number of aircraft fire tragedies including the following:

Crash Fires

Jan. 11, Rio de Janeiro, Brazil, Lufthansa Airlines, Constellation, 36 killed.

Mar. 6, Managua, Nicaragua, TACA International Airlines, Viscount, 15 killed.

May 20, Ushuya Air Base, Japan, U. S. Air Force, C-130, 7 killed.

Flight Fires

June 26, Busto Arsigio, Italy, Trans World Airlines, Constellation, 69 killed.

June 30, Ishikawa, Okinawa, U. S. Air Force, F-100, 21 killed, 100 injured.

Sept. 30, Sao Paulo, Brazil, Viacao Aerea Sao Paulo, Transport aircraft, 20 killed.

Oct. 29, near Athens, Greece, Olympia Airways, Transport Aircraft, 18 killed.

Motor Vehicles

There were six large loss of life fires in motor vehicles resulting in the death of 65 persons. Thirteen died in two automobile fires, 28 in two bus collisions, and 24 watching or fighting two truck fires.

Automobiles

Automobile of Earl Martin
West Brooklyn, Ill., Nov. 9, Early Morning
7 Killed

An early morning three truck – one car crack-up on U. S. Route 30 resulted in the deaths of seven persons. The six members of the Earl Martin family were trapped in their 1958 4-door, hardtop Pontiac when a United Parcel trailer unit landed on top of their car following the collision. Fire involved most of the vehicles and burned the Martin family to death and also killed the driver of one of the trucks. Other details have not been reported.

Automobiles of Edwardo Valdez, and John Marinilla
near Salinas, Calif., Dec. 18, 6:05 P.M.
6 Killed

A 1958 two-door Chevrolet hardtop carrying a mother, father and their two children, was stopped preparatory to making a left turn off U. S. Route 101. A 1957 four-door Oldsmobile sedan carrying 2 people, hit the rear of the Chevrolet rupturing the fuel tank.

A gasoline fire involved both vehicles killing the four persons in the front vehicle, and inflicting burns that were eventually fatal to the two passengers in the rear car.

Buses

Truck Converted to Bus
near Phoenix, Ariz., June 8, time unreported
16 Killed

Sixteen farm laborers were burned to death and 32 others were injured when the heavily loaded makeshift bus in which they were riding hit a tree and burst into flames. Witnesses reported that the truck exploded "like a clap of thunder" on impact. Flames engulfed the combustible passenger compartment (wood frame, canvas side and top) as the occupants, not immobile from the crash impact, fought to reach safety through the single rear doorway which was partly blocked by baggage and a water barrel. Those near the front of the passenger area were caught by flames before they could escape.

Layton's Bus Service and Cargill, Inc. (truck)
New Brunswick, N. J., Oct. 9, 12:45 A.M.
12 Killed

Eighty students and three teachers from the Trenton State College (for teachers) were returning from an evening at a Broadway play in two buses. As one bus followed the other toward Trenton an empty semitrailer tank truck began moving up from behind. The driver, who may have been on duty as much as 61 of the last 66¾ hours, had been dispatched from Long Island to pick up a load

Wide World

Fires following highway accidents seem to be on the increase. Six lost their lives by fire after this collision on U. S. Route 30 in West Brooklyn, Ill., November 9, 1959.

Wide World

This truck, converted into a bus, was a death trap for 16 after the vehicle collided with a tree near Phoenix, Ariz., on June 8, 1959, and fire ensued.

Wm. D. Tallman

A truck struck this bus, which was stopping for a traffic light, and a 120-gallon-capacity fuel tank on the bus ruptured with the ensuing fire resulting in 12 deaths. This tragedy occurred on October 9, 1959, in New Brunswick, N. J.

Wide World

Damage wrought by the ignition of a truckload of explosives and blasting agents in Roseburg, Oreg., on August 7, 1959, at 1:14 A.M. reported on the next page.

of paint oil in Philadelphia. A light mist and fog were present but this did not obscure visibility and the pavement was almost dry. As the buses approached a slightly depressed intersection, the traffic light there flicked to amber. The first bus was able to proceed through, but the second had to slow down to stop. The trailer truck did not slow down and rammed the rear of the bus at an estimated 35 miles per hour.

The bus's 120 gallon fuel tank contained approximately 70 gallons of gasoline. This fuel tank was mounted under the floor of the bus just forward of the rear seat. As the truck's bumper tore into the rear of the bus the fuel tank was mashed. An 18-inch rip in the tank resulted in most of the gasoline being sprayed into the interior of the bus. The vapors ignited.

Because of these sudden flames, the occupants panicked; four girls escaped from the side-mounted emergency door, most of the remaining students pushed forward and out the main entrance door in the front. Fortunately these doors had not been jammed in the crash. Ten persons, one a faculty member, could not escape in time. Two of the girls who did escape were so badly burned that they subsequently died. The truck driver was pinned by his ankle in the truck cab but was rescued by the fire department.

The truck driver is reported to have received ten written traffic violations in the three states of N.Y., Pa. and N.J. for speeding (3), passing red lights (2), passing signal lights (1), failing to keep to the right (1), failing to comply with an officer's signal (1), and operating without lights, or with defective lights (2).

At the time of the accident the truck showed no signs of slowing or braking. An after-the-fire examination of the brakes revealed defects. The ICC investigation of the accident concludes in part "this accident with its tragic results was caused by the operation of a property-carrying vehicle by a driver who was not alert and who otherwise was of questionable suitability and competence."

Trucks

Truck of Pacific Powder Company
Roseburg, Oreg., Aug. 7, 1:14 A.M.
13 Killed

A truck carrying 4½ tons of blasting agents and 2 tons of explosives was parked and left unattended on a downtown street in Roseburg, Oreg. A fire in a nearby builders' supply warehouse exposed the truck and ignited the cargo. The blast killed 13 people, injured 125 others and caused over $10,000,000 property damage within a roughly circular area extending about 1800 ft. from the center of the explosion. (For a full report see pages 195–207 of the January 1960, NFPA QUARTERLY.)

Sungas Corporation and Branch Transportation Co. near Pottsville, Pa., June 2, 8:00 A.M.
11 Killed

An LP-Gas tank truck was struck in the rear by a trailer truck. A fire broke out and burned for about 45 minutes before a failure due to localized overheating at the rear of the LP-Gas cargo tank occurred. This failure caused the tank to rocket forward striking a group of spectators 700 feet away. The main portion of the tank came to rest 900 feet from the point of the violent rupture.

In addition to the 11 killed by the rocketing tank, 10 others were injured. (For a full report see pages 89–97 of the October 1959 QUARTERLY.)

Ships

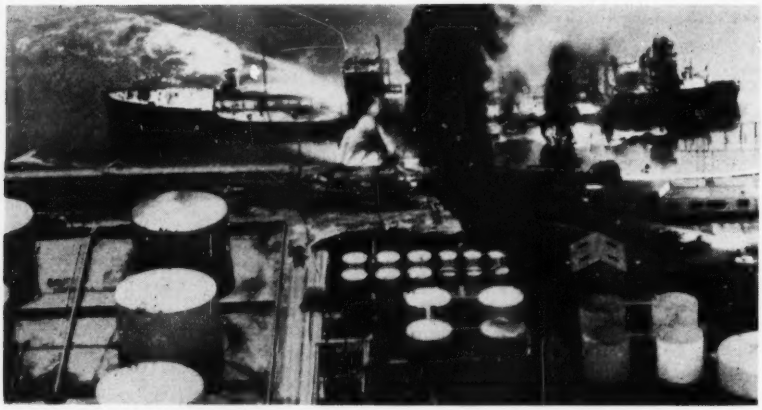
There was one ship fire which resulted in the death of 8 people.

S. S. Amoco Virginia
Galenia Park, Tex., Nov. 8, 9:30 P.M.
8 Killed

One of the two gasoline barges loading the *S.S. Amoco Virginia* had previously been involved in a collision. The accident caused a hole in the barge's side. This hole was temporarily patched with crates. Gasoline leaking from this hole and gasoline leaking from a faulty loading hose spread on the water. This gasoline spill was probably ignited by the running lanterns on a barge, down channel from the tanker, that was proceeding upstream. The ignited gasoline burned back to the tanker and barges. An explosion in one of these gasoline barges threw gasoline onto the ship where an explosion occurred in two of her portside tanks. The explosions and ensuing fire killed 7 men, injured 41 others and destroyed the $6,000,000 vessel.

United Press International

The October 1959 NFPA QUARTERLY contained a full report on this highway fire near Pottsville, Pa., June 2, 1959, responsible for the deaths of 11 bystanders watching an LP-Gas tank truck burn after a collision accident.



United Press International

The S. S. Amoco Virginia burns at dockside, Galenia Park, Texas, on November 8, 1959, after a gasoline spill on the channel waters was ignited.

The eighth victim was a fire fighter, who fell into a gasoline-filled hold and drowned.

Trains

There were two train wrecks involving fire that resulted in the deaths of 31 spectators, picnickers, and railroad workers.

Missouri Pacific Railroad Freight Train
Monroe, La., Jan. 22, 11:15 P.M.
8 Killed

Just after 11:00 P.M. two police officers in a patrol car noted sparks coming from the journal boxes of a pulp wood car on a freight train running on a track parallel to the highway. They flashed a flashlight into the cupola of the caboose and obtained no response. Speeding up they tried the same tactic with the engineer who understood and started to respond. As he did the car derailed itself and the next 32 cars.

One of the derailed cars was an 11,000 gallon insulated tank car that had been loaded with 10,250 gallons (at 59°F) of propylene. This car came to rest, slightly off vertical, next to three other tank cars containing diacetone alcohol, vinyl acetate, and glycol. All of these tank cars were burning. The flames issuing from the glycol tank were directed against the side of the propylene car. Propylene vapors issuing from the car dome were ignited and burned freely.

Nineteen hours later (6:00 P.M. Jan. 23) the propylene car was moved away from the other three tank cars and was raised to a vertical position although the vapors continued to burn at the dome. One end of the car was still fouling the track. About 30 minutes later while most of the wrecking crew were eating supper some distance away, a bulldozer operator pulled the propylene tank car off the track to clear the right of way. At this time the car rolled onto its side. With the dome now in a horizontal position, the intensity of the fire at the dome greatly increased.

About 30 minutes later the propylene tank, its strength weakened by the exposing flame, ruptured violently. The tank split open and traveled 200 feet away. Eight persons (all on the scene officially) were killed — three immediately and five succumbing to burns later — and 75 persons (3 spectators, 3 city fire department employees, 1 off-duty railroad employee, and 68 others officially on the scene) were injured. Some of the injured had their burns intensified when they dove into a ditch that looked water-filled. It actually contained liquid caustic from another tank car which had ruptured. Excellent work by the state and local police established road blocks, and detours. Radio broadcasts also

warned spectators away. These precautions were sustained throughout the accident. The success of these efforts prevented the injury of spectators as shown by the fact that there were no deaths and only three injuries to bystanders.

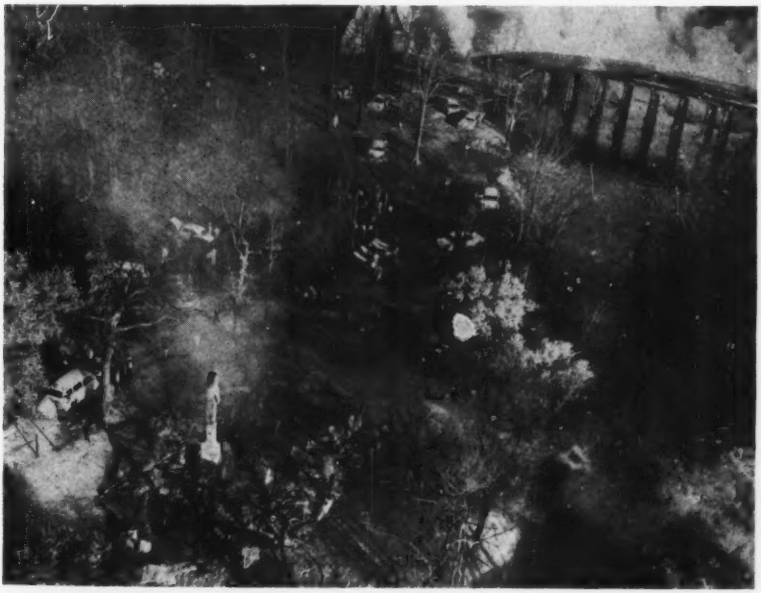
The blast was felt over a 5 mile radius and was seen by an airline pilot 125 miles distant.

Seaboard Air Line Railroad Company Freight Train
Meldrim, Ga., June 28, 3:40 P.M.
23 Killed

About 3:40 P.M. on Sunday, June 28, 1959, 23 persons (ages 5 mos. to 46 years) lost their lives and a number of others were severely burned in an explosion and fire following a freight train wreck near Meldrim, Georgia. The disaster occurred as the 124-car train crossed a wooden trestle spanning the Ogeechee River. Sixteen cars (No. 107 to No. 122) in the train became derailed and eleven cars (No. 109 through No. 119, including two LP-Gas tank cars (No. 113 and No. 114), plunged part way down an embankment at one end of the trestle. A picnic area was at the foot of the trestle where more than 100 persons, including many children, were picnicking and bathing. Unfortunately, as the two LP-Gas tank cars rolled over the embankment, a car coupler or drawbar from the rear tank car was jammed through the head of the leading tank car. This large gash permitted LP-Gas to disperse over a very wide area until it was ignited, probably by a picnic cooking fire.

After the initial blast the LP-Gas continued to burn at the hole in the damaged tank car until the next day. The intense fire exposed the second LP-Gas tank car, causing the safety relief valve on that car to discharge vapors which ignited. This car had received damage to the running gear and outer jacket, but the tank itself was intact despite a few dents and bruises to the outer shell where the insulation had been torn off.

This remote recreational area, located about 18 miles northwest of Savannah, Georgia, was one of the favorite local picnic spots. Its inaccessibility was a severe handicap in the rescue operation following the accident since a winding narrow dirt road



News-Press, Savannah

A few hours earlier this was a placid scene where picknickers were enjoying a riverside Sunday afternoon. Tragedy struck when LP-Gas escaping from a derailed tank car ignited. A hole had been punched in the tank car at time of derailment.

through the woods was the only means of access. Observers reported that most of the cars in the train had uneventfully passed over the trestle when suddenly, as the end of the train came into view, a peculiar bumping was noted by several picnickers. Moments later cars were strewn across the tracks, some piled up on the river bank with several remaining on the trestle, including the caboose.

Several train crew members in the caboose, who realized the seriousness of the wreck, saw the released LP-Gas vapors spreading over the river and surrounding wooded grove and tried to warn all of possible danger. Almost at once a flash fire (explosion) occurred as the extending vapor cloud ignited. All persons within the area were horribly burned. Automobiles, trees, and a 1-story wooden cabin were destroyed. Part of the wooden trestle was badly burned, including some piling. The LP-Gas vapors continued to burn at the damaged tank car until all of the gas was consumed.

Rescue operations were initiated by the train crew conductor who radioed the train engineer. The engineer got in communication with the local train dispatcher who issued a call for help to assist in removal of the injured. Swift action was taken by local officials, the State Highway Patrol, and local fire departments. Traffic over the narrow dirt road was slow and difficult because of the congestion until roadblocks were set up to control traffic. Then, ambulances were shuttled in and out quickly. The U. S. Air Force sent helicopters to assist in evacuating the injured. Emergency calls at the disaster scene were relayed via police radio until a mobile telephone truck unit was rushed to the area to facilitate direct communication with Savannah and other nearby communities.

On Thursday, July 9, 1959, the Interstate Commerce Commission conducted a hearing in Savannah in an effort to determine the cause of the disastrous wreck. This hearing was held jointly with officials of the Georgia Public Service Commission which was also probing into this accident since there had been quite a few derailments within Georgia in 1959. Testimony at the hearing showed that the track structure had been resurfaced on June 12, 1959 and that the day of the accident had been the warmest since (98°F). Examination of the wreck site indicated that the rails had expanded severely in the heat and were under heavy compression as the rails at the trestle ends were anchored. The rails thus spread outward allowing car No. 107 to derail. There did not appear to be any indication of any defect in the tank cars. Early press reports had erroneously indicated that the tank cars had exploded.

LP-Gas tank cars are built and maintained in accordance with the Federal Code of Regulations Title 49 — Transportation, Parts 71–90 as promulgated by the Interstate Commerce Commission covering preparation and handling of explosives and other dangerous articles for shipment by common carrier. Through the years these regulations have proved adequate since a number of LP-Gas tank cars that have been involved in serious rail accidents have successfully withstood severe damage. Compliance with ICC Regulations does not protect against severe impact damage such as occurred at Meldrim, Georgia.

See also photos of this accident on pages 26 and 35 of this issue of the QUARTERLY.

Editor's note: This fire was originally reported in the August 1959 issue of NFPA *Fire News*.

1959 Large Loss of Life Fires —

In Institutional Properties

Thirty-eight persons died in 1959 in the U. S. in three separate fires because they were placed in areas from which there was no escape or because rescue of the confined individuals was not possible. Each of these incidents was a separate indictment of those in authority as all of these deaths were due to a combination of improper building design and poor or thoughtless administration of the institutions.

In the largest single loss, 68 boys were locked in a highly combustible, brick walled, unsprinklered building for the night, and no substitute was supplied for a sick building supervisor who had a key to release the imprisoned inmates; 21 were killed. In a second corrective institution, a highly combustible padded cell was used in an otherwise fire-resistive jail, no guards were placed on the floor with the inmates, nor was the cell release mechanism placed where it could be reached by the guards in case of a hot fire; 8 died. In a home for the aged, patients were placed on the second floor of an unsprinklered combustible nursing home; 9 were killed.

United Press International

Eight patients of the Glen Ellyn Acres Nursing Home died on the second floor of this 40-year-old converted mansion after a fire of probable electrical origin started on this floor. The ninth victim was an assistant Fire Chief who had a heart attack while fighting the fire. **(See story on page 38.)**

Glen Ellyn Acres Nursing Home
Glen Ellyn, Ill., Jan. 30, 10:40 A.M.
9 Killed: All Adults

Eight of the 12 occupants of six second-story rooms lost their lives when fire broke out in this 40-year-old, 2-story combustible mansion which had been converted to a nursing home. The ninth victim was the assistant fire chief who suffered a fatal heart attack while fighting the fire.

At approximately 10:44 A.M. a second-floor attendant, on seeing smoke coming from around a closet door, opened the door and was met by a burst of smoke and flames that forced her back. As flames spread into the room, she assisted a patient down the open stairway to the first floor, then started back upstairs but was prevented from doing so by flames burning at ceiling height above the stairwell. (Some of the ceilings were finished with combustible fiberboard acoustical tile.) She then ran outside and assisted another attendant in getting three patients down an outside wooden stairway.

In the meantime another attendant had telephoned the fire department as soon as the fire was discovered. Arriving in about three minutes, police and firemen found the nine first-floor patients standing in the front hallway looking upstairs. These survivors were taken outside as fire fighters wearing breathing apparatus fought their way upstairs with booster lines. They were immediately forced down by the heat and flames. One elderly patient was alive when taken down a fire department ladder but died on the way to the hospital.

A wiring fault was the probable cause of the fire. Wiring repairs had been made by an electrician in the second story on the day preceding the fire, and earlier on the day of the fire two fuses blew twice. After the second time, the blown fuse was not replaced and the electrician was called.

Those occupants who died ranged from age 67 to 80, four being 80 years old.

Detention Dormitory at the Arkansas Negro Boys Industrial School
Wrightsville, Ark., March 5, 3:15 A.M.
21 Killed: All Boys 15 to 17 Years Old

Twenty-one of the 68 boys (mostly 15 and 16 years old) that had been locked in the barracks-type dormitory for the night lost their lives when fire broke out in an adjoining section of the 1-story brick veneered combustible building. The caretaker who normally stayed in the building was absent due to illness. No substitute had been provided.

Ignition of the combustible fiberboard ceiling by the vent pipe from a wood burning stove in the recreation room was a possible cause. The fire was spreading along the ceiling and had gotten into the undivided attic before one of the boys was awakened at 3:15 A.M. Kicking out the heavy wire screening on one of the windows he escaped and ran to another building to give the alarm. As the other boys awoke and found the room in which they were caged rapidly filling with smoke they struggled wildly to get out through windows. Twenty-one were trapped by flames, heat and smoke before they could escape.

In the absence of a school fire brigade, local fire department or water supply, there was no fire fighting of any consequence. One engine company responded from Little Rock, eight miles away.

The Arkansas Governor was quoted in the newspapers as saying "everything was fine" when he investigated the school about a year before the fire.

The School's board of trustees subsequently discharged the superintendent, for his failure on the night of the fire to arrange for a substitute caretaker.

United Press International

Twenty-one boys died in the fire which destroyed this barracks-type dormitory in which they had been locked for the night.

Wide World

Fire started in a foam-rubber padded cell by an inmate resulted in the loss of 8 lives in this Ocean County, N. J., fire-resistive jail building.

Ocean County Jail
Toms River, N. J., Aug. 23, 11:30 A.M.
8 Killed: All Adult Males

Eight men in locked cells were killed and 12 men were injured by a fire in the Ocean County Jail at Toms River, N. J., about 11:30 A.M.

The 2-story and attic brick-faced, fire-resistive jail building was built in the mid 1920's to house 28 prisoners. Since then the County sheriffs have made repeated recommendations for additional space. These recommendations had been continually ignored by other County authorities. To keep up with the increasing demand for space, the sheriffs were forced to add another bunk to each cell. Even this expansion was inadequate and mattresses were laid on the floor to take care of the overflow. At one time the jail was called on to accommodate 90 prisoners. At the time of the fire there were 65 inmates.

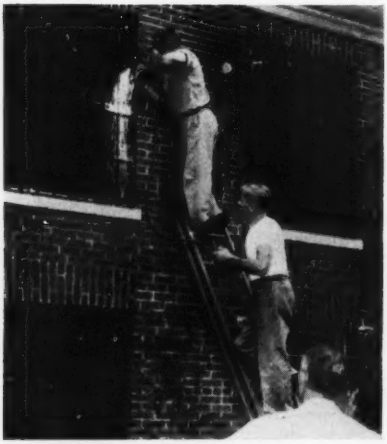
The combustibles within the building were limited to prisoners' clothes, bedding, and a padded cell. This cell was actually a piece of furniture on wheels. Kept in one corner of the second floor, it was built of a solid steel plate box, lined inside with wood planks. The wood interior was covered with 4-inch-thick foam rubber. The foam rubber was covered and supported by heavy duck canvas.

The second floor of the jail was divided into three separate sections. One held seven male inmates and the padded cell. Another section, the women's, was totally enclosed and was separated from the first by a corridor with a wall of heavy glass panelling. The last section (the largest) was separated from the other two by a door in the corridor.

During the summer the upper halves of the jail windows were opened to let air into the crowded quarters. Besides the heavy window bars, the windows were covered by fine mesh screening to protect the prisoners from mosquitoes and flies.

A thirty-five-year-old man had entered a nearby jail on Saturday. He promptly tore up his cell. After examination it was decided that he should be confined to the padded cell at the Ocean County Jail until he could be placed in a mental institution on Sunday.

Sunday morning a trusty was working on the second floor of the jail. The occupant of the padded cell pleaded for a cigarette. The trusty felt sorry for the man and gave him one.



Wide World

Windows in the jail had heavy bars and fine mesh screening which handicapped evacuation and rescue.

The women noticed smoke first, then someone shouted fire. The smoke was coming from over and under the steel door of the padded cell. The man in the cell had managed to ignite the foam rubber with his cigarette. A prisoner confined in an end cell of the largest section was able to reach out and touch the open corridor door dividing his section from the one on fire. He pushed the door shut. This move saved the 15 inmates in the large section while the glass panel protected the women in the other section from smoke.

The two guards on duty responded immediately to a trusty's shout of "fire." Racing up the stairs, they tried to extinguish the now visible flames in the padded cell with portable extinguishers. The heat in the second floor corridor was so intense that they could not reach the release lever for the cells in that area. At this point black, stringy, smoke from the burning foam rubber was beginning to develop.

The guards immediately called for assistance from fire and police agencies. Masked fire fighters made attempts to reach the unlocking mechanism for the cells in the involved section. The first attempt was defeated by a fire gas explosion which blew the four-man rescue party back down the stairway. These men and an assisting sailor were taken to the hospital for treatment of their severe burns. The key to the unlocking device was dropped and lost in the explosion.

The stringy soot from the fire was beginning to plug up the mesh screens on the cell windows, preventing smoke from escaping.

Another key was obtained and more attempts were made to free the seven men. All failed until the choked screening could be pulled away from the windows and the smoke vented. As the smoke lifted, the unlocking mechanism was operated. While fire fighters completed extinguishment of the padded cell, the bodies were removed.

The requirements of the Building Exits Code (NFPA No. 101) should be followed in the provision of life safety in penal institutions. The requirements of the Building Exits Code overlooked in this case were:

Combustible material within a penal institution must be limited in every conceivable way. Foam rubber, certain plastics, and other materials known for their rapid, toxic, or smoky burning characteristics should not be permitted in any areas.

Cell release mechanism or auxiliary cell release operating stations should be located so as to afford quick emergency operation.

Guards should be continuously on duty in each confinement area.

Guards should be trained in unusual emergency procedure.

Editor's note: This fire was originally reported in the November 1959 issue of NFPA *Fire News*.

1959 Large Loss of Life Fires —

Other Fatal Fires

Three other large loss of life fires occurred during the calendar year 1959 which were responsible for a total of 18 deaths. One was an explosion that blew apart a compressor under test and killed six men. The second was a rupture of an aboveground gasoline tank during a fire that killed six men fighting the fire. The last was a fire in an iron mine that, when exposed by an underground shift of earth, was wet by water that had been trapped underground. The steam thus created rushed through the mine burning 6 men to death.

Ingersoll Rand Co.
Phillipsburg, N. J., Feb. 11, 2:28 P.M.
6 Killed: All Adults

A test was being run on a high-pressure, high-speed centrifugal compressor. The test had been proceeding normally on the usual test loop for about six hours when suddenly an explosion ripped apart the test apparatus and severely damaged the test building. Windows up to 500 feet away were smashed. Six of the ten employees working on the test were fatally injured, six other persons were hospitalized and twenty-four others received minor injuries. Several small fires resulted which were easily controlled by hand-operated extinguishers.

The explosion was the result of ignition of a combustible hydrocarbon-air mixture

Copyright 1959 by Charles W. Campbell from UPI

Six firemen were killed fighting this Kansas City gasoline bulk plant fire.

within the test loop. The source of ignition indicated by the report was a spark from accidental contact between the compressor's moving parts or heat produced by the work done on the circulating air. Oil had been previously noticed at the low points of the closed loop test system. How the oil entered the test loop was not definitely indicated by the report.

The explosion was thought to have originated in the compressor under test and reached focal points in the low pressure (528 psig) side of the test loop. The discharge temperature at the time of the explosion was 400°F; and though the discharge pressure at the time of the explosion was not reported, it is known that the compressor was designed to operate at a 1,920 psig discharge pressure with a 916 psig inlet pressure.

Pyramid Oil Company Bulk Plant
Kansas City, Kans., Aug. 18, 8:20 A.M.
6 Killed: All Adults

The rupture of a horizontal gasoline tank during a fire in a bulk plant sent a seething tidal wave of burning gasoline forward to engulf fire fighters, killing 5 and a civilian helping them and injuring 64 others.

A complete report of the incident is given in the November 1959 issue of the NFPA *Firemen* magazine, pages 8–10. (See also the frontispiece of the October 1959 QUARTERLY and the article on "Inadequate Vents on Flammable Liquid Tanks" published in the January 1960 QUARTERLY, pages 208–216.)

Sherwood Mine
Mineral Hills, Mich., June 1, 9:00 A.M.
6 Killed: All Adults

The collapse of a supporting pillar under an abandoned stope (a very large vertical underground room) opened up an underground fire in carbonaceous slate. The shifting earth and sand evidently caused pocketed water to enter the fire area. Expanding steam roared through one of the mine tunnels. Of the 30 miners underground at the time, four were burned to death by the steam, eight were injured with two dying subsequently, and 18 were rescued uninjured.

Meetings of Board of Directors

Montreal, P.Q., Canada, May 16, 1960

Members Present

T. Seddon Duke, Chairman
Henry G. Thomas, President
Loren S. Bush, Vice-President
J. Sharp Queener, Vice-President

Dale K. Auck	Paul C. Lamb
Warren J. Baker	Elmer O. Mattocks
W. H. Berry	Carroll E. Shaw
Frank J. Fee, Jr.	E. C. Wood
W. H. Forristall	

Percy Bugbee, General Manager

1. The report of the Chairman of the Board to be presented at the opening general session of the annual meeting was approved.

2. The report of the Treasurer, Hovey T. Freeman, to be presented at the first general session of the annual meeting, was approved. The Board recorded its special thanks to Treasurer Freeman for his long and devoted service to NFPA.

3. The Board approved the appointment of Mr. W. A. McAdams of the General Electric Company of New York as an alternate to Mr. H. H. Watson, General Electric Company, Bridgeport, on the Electrical Correlating Committee.

4. The Board approved plans for the Fall Conference scheduled for the Deshler Hilton Hotel in Columbus, Ohio, from November 14–16, 1960. There was discussion of the proposal to consider a Fall Conference in London in 1961. No action was taken.

5. The Board took notice of the fact that members Robert C. Byrus of the University of Maryland and A. Leslie Ham of the Canadian Underwriters Association were given Distinguished Service Awards by the Association.

6. There was discussion with respect to the chairmanship of the Sponsors Committee. This matter was held open for further report by the General Manager at the next meeting of the Board.

7. The General Manager reported informally on the progress in connection with raising funds for the proposed rural field engineering service.

8. It was voted to hold the next meeting of the Board in Boston on June 27.

Boston, Mass., June 27, 1960

Members Present

T. Seddon Duke, Chairman
Loren S. Bush, President
J. Sharp Queener, Vice President
Warren J. Baker, Vice President
John A. Neale, Past President
Henry G. Thomas, Past President
Hovey T. Freeman, Secretary-Treasurer

W. H. Berry	Jerome Lederer
A. Sidney Briggs	Elmer O. Mattocks
J. R. DeHaven	Carroll E. Shaw
Frank J. Fee, Jr.	George F. Wahl
R. H. Ferguson	W. M. Wetzel
W. H. Forristall	E. C. Wood
Paul C. Lamb	

Merwin Brandon, Chairman, Electrical Section

Percy Bugbee, General Manager; Robert S. Moulton, Technical Secretary; Horatio Bond, Chief Engineer; George H. Tryon, Assistant Technical Secretary.

Business Transacted

1. The following officers were elected in accordance with the recommendation of the annual meeting: President — Loren S. Bush; Vice-President — J. Sharp Queener; Vice-President — Warren J. Baker; Secretary-Treasurer — Hovey T. Freeman; Chairman, Board of Directors — T. Seddon Duke.

2. Messrs. J. R. DeHaven and Frank J. Fee, Jr. were elected to complete the Nominating Committee for 1961.

3. Plans for the 1961 annual meeting in Detroit, Mich., May 15–19, were approved. Future meeting dates and places were also approved as follows: 1962 — Philadelphia, May 14–18; 1963 — San Francisco, May 20–24; 1964 — Dallas, May 18–22. The General Manager was authorized to proceed tentatively with plans for a 1965 annual meeting in Boston.

4. The Program Committee for the 1961 annual meeting was appointed consisting of the President, Chairman of the Board of Directors, and the General Manager.

5. Plans for the Fall Conference in Columbus, Ohio, November 14–16, were approved. Tentative plans for future fall meetings were reviewed. A suggestion from Vice President Baker that meetings should not be concentrated in the central part of the country was referred to the General Manager for consideration.

6. The report of the Treasurer, Hovey T. Freeman, was approved. This indicated a healthy financial condition.

7. The budget for 1960–61 submitted by the Finance Committee consisting of Messrs. Freeman, Duke and Bush was approved.

8. Mr. Bugbee reported on the Sponsors Committee, indicating the valuable function performed by this committee with respect to securing contributions to the activities of the Association and the importance of securing a new Chairman to serve for the year 1960–61. He asked for suggestions as to the selection of a Chairman. There was general discussion and several members of the Board indicated willingness to assist.

Reports on Special Projects

9a. Mr. Brandon, Chairman of the Electrical Section, reported on the activities of the Section and its promotion of the National Electrical Code, indicating that there is a widespread movement by electrical contractors and labor organizations to promote local ordinances specifying the use of metallic conduit under conditions where it is not required by the National Electrical Code. He indicated vigorous opposition to such restrictive legislation which unnecessarily increases the cost to the public of electrical installations and cited activities of the electrical field engineer in responding to requests for assistance in such situations. He stated that the services of the Electrical Field Engineer are very satisfactory. He also referred to the difficulties involved in securing compliance with National Electrical Code requirements on circuit breakers and said that Underwriters' Laboratories' position in the matter was to allow reasonable time for manufacturers to comply with the new Code requirements.

b. Mr. Elmer Mattocks reported on the flammable liquids field service project indicating a high degree of satisfaction with the activities of the NFPA Flammable Liquids Engineer, citing his activities towards securing general acceptance of NFPA standards in this field and opposing special requirements by states and cities which would place an undue burden on industry without securing commensurate safety.

c. Mr. Moulton reported on the activities of the Gases Field Engineer, reporting similar satisfaction with his activities and a similar direction in his field of operations.

d. Mr. Warren Baker, Vice President of the Society of Fire Protection Engineers, reported on the activities of the Society indicating continued growth and progress.

e. Mr. Bugbee reported for the Fire Marshals Association of North America. He referred to the increasing cooperation between the state and municipal fire marshals and the NFPA and expressed general satisfaction with the activities of this Section of the NFPA.

10. A proposed change in the Constitution of the Society of Fire Protection Engineers recommended to the Board by two-thirds vote of the Society at its meeting in Montreal was approved.

Technical Committee Activity

11. Standard No. 305 on Gasoline Fueling Stations for Small Craft was rescinded on recommendation of the Committee on Flammable Liquids in view of the fact that the subject matter of this standard is largely covered in the NFPA Flammable Liquids Code, No. 30.

12. A proposal for the appointment to the Committee on Flammable Liquid of members from the United Kingdom, West Germany and other countries, was discussed and approved in principle as consistent with NFPA general policies. The proposal by the Executive Committee of the Committee on Flammable Liquids specified that these representatives be appointed as liaison representatives. Mr. Mattocks said that he felt that the voting responsibilities of such members should be specifically defined. Mr. Lamb, Chairman of the Flammable Liquids Committee, said that his committee in making the proposal had assumed that such members would not vote. After further discussion, the matter was referred to the Technical Advisory Committee for consideration of general policies involved which apply to all NFPA committees.

13. Proposed revisions of the advisory pamphlet "Home Fire Alarm Systems," NFPA No. 74M, as submitted by the Committee on Signaling Systems and Thermostats pursuant to the action of the annual meeting, were discussed and approved.

Technical Advisory Committee Report

14. Chairman T. Seddon Duke of the Technical Advisory Committee, presented recommendations on behalf of the committee on which action was taken as follows:

a. It was voted to approve the subdivision of the Committee on Chemicals and Explosives into Sectional Committees as follows, with an Executive Committee consisting of the general Chairman and the Chairmen of the Sectional Committees ex-officio.

SECTIONAL COMMITTEE ON EXPLOSIVES — To review and revise as necessary the Code for Explosives and Blasting Agents (No. 495). To review and revise as necessary Standard for Cellulose Nitrate Motion Picture Film (No. 40), Standard for Pyroxylin Plastic in Factories (No. 42), and Standard for Pyroxylin Plastic in Warehouses (No. 43). To study special problems involving explosives, propellants and related materials.

SECTIONAL COMMITTEE ON HAZARDOUS CHEMICAL REACTIONS — To develop a manual on extra hazardous chemical reactions and to maintain this manual current by the preparation of addenda or revisions.

SECTIONAL COMMITTEE ON PROPERTIES OF HAZARDOUS CHEMICALS — To revise the Table of Common Hazardous Chemicals (No. 49) and to maintain this Table current by the preparation of addenda or revisions. To develop recommended fire hazard ratings of chemicals.

SECTIONAL COMMITTEE ON STORAGE, HANDLING AND TRANSPORTATION OF HAZARDOUS CHEMICALS — To develop and maintain cur-

rent a code for the safe storage, handling and transportation of hazardous chemicals by classes. To develop and maintain current similar codes for specific chemicals when these are warranted by virtue of widespread distribution or special hazards.

SECTIONAL COMMITTEE ON EXTINGUISHMENT OF CHEMICAL FIRES — To develop and publish information on special techniques of fighting fires in individual chemicals or classes of chemicals. To develop and maintain current a standard for special fire protection measures in locations made extra hazardous by virtue of chemical storage.

b. It was voted to approve the subdivision of the Committee on Dust Explosion Hazards into Sectional Committees as follows:

SECTIONAL COMMITTEE ON WOOD AND SOLID FUEL DUSTS — Standards Nos. 60, 653, 664.

SECTIONAL COMMITTEE ON GRAIN AND FOOD PROCESSING DUSTS — Standards Nos. 61A, 61B, 61C, 62, 64, 656, 657, 661.

SECTIONAL COMMITTEE ON METAL DUSTS — Standards Nos. 65, 651, 652.

SECTIONAL COMMITTEE ON MISCELLANEOUS DUSTS — Standards Nos. 654, 655.

The main committee will retain jurisdiction over Standard No. 63, Prevention of Dust Explosions in Industrial Plants. There will be an Executive Committee consisting of the General Chairman and the Chairmen of the Sectional Committees, ex-officio.

c. It was voted to approve the formation of a new Sectional Committee on Aircraft Fuel Servicing in the Aviation Committee, taking this subject away from the present Sectional Committee on Aircraft Maintenance and Servicing.

d. A new Committee on Heights and Areas was authorized, subject to authority to the Technical Advisory Committee to combine this subject with a proposed project on underground structures now under consideration, if considered advisable, subject to confirmation by the Board at a later meeting.

e. It was voted to submit the 1960 Edition of the Building Exits Code (No. 101) to the American Standards Association for approval as an existing standard, with revisions to be handled under the proprietary sponsorship method.

f. It was voted to concur in Underwriters' Laboratories' submittal of their Standard on Industrial Gas Heating Equipment to the American Standards Association for approval as an existing standard.

g. It was voted to refer to the Committee on Building Construction the subject of air supported structures, with particular reference to whether they should be classified as buildings or as tents.

h. The following scope statement for the Committee on Hospitals was approved: "Deals with life safety in hospitals, including flammable anesthetics, medical gases, emergency electrical systems, and related subjects. On subjects within the jurisdiction of other NFPA committees the concurrence of the appropriate other committee is required."

i. New and revised provisions of the Regulations on Committee Procedure (Year Book, 1959, page 11), designed to clarify voting procedures and to eliminate inactive committee members, to provide a consistent pattern for the organization of sectional committees, and for the issuance of official interpretations were adopted as follows.

Appointment of Committees.

14. Committees shall be subject to annual reappointment and those who have consistently failed to return ballots or who have not attended meetings or otherwise exhibited interest in committee activities may not be reappointed.

(a) Unchanged.

Committee Organization.

23. Subject to the approval of the Board of Directors in each case, committees may create sectional committees to deal with specialized subdivision of their fields. Sectional committees shall be subject to the approval of the Board as regards scope statements, chairmen and personnel, the same as for regular committees. Sectional committees shall be distinguished from subcommittees in that they have continuing responsibility of a primary character, can be created or discharged only by action of the Board, and are identified by names in the Year Book and in publication of their reports. Their votes shall be recorded as specified in Section 52.

(a) Sectional committees shall operate under the general direction of their parent committees and shall report to the Association through the parent committee, whose ballot shall also be reported.

(b) The parent committee may include the entire personnel of all sectional committees reporting to it, or may be a general or executive group. In any case, all sectional committee chairmen shall be ex-officio members of the parent committee.

Reports — Precedures.

52. Except by special permission of the Board of Directors or unanimous consent of the annual meeting, no technical committee report proposing new standards or amendments to existing standards shall be presented to the Association in annual meeting which is not received by the General Manager before March 15 of that year complete with vote statement, in form for advance publication. Such reports shall have been submitted to vote of the committee and must have received the approval of the majority of those voting. A statement in the following form shall accompany every committee report:

This report has been submitted to ballot of the committee, which consists of_____voting members, of whom_____have voted affirmatively. Mr. _____ and Mr._____have voted negatively. Mr. _____ _____has asked to be recorded as not voting. Mr._____ has not returned any ballot.

Interpretations.

57. Committees may establish formal interpretations procedures for the purpose of providing official exploration of the meaning or intent of specific provisions of standards, under the following conditions, but nothing in the following shall be construed to prevent any committee chairman or member from commenting informally on the meaning or intent of any provision of any standard, provided that the informal personal nature of the comment is clearly identified.

(a) Requests for interpretations shall be submitted to the appropriate committee through the NFPA office. They shall provide five identical copies (or more if so specified) including drawings, if any. Each shall be directed to a single subject with identification of the particular paragraph or paragraphs in question, and, if an actual field situation is involved, shall identify all parties at interest.

(b) Committee officers may rephrase questions if desired or refuse to consider requests for interpretations which they find not in proper form.

(c) Requests shall be submitted to an interpretations subcommittee, made up of five or more committee members or alternates, selected by the Chairman on the basis of their familiarity with the subject in question. The personnel of interpretations subcommittees may be varied for different interpretations.

(d) In any case where there is more than one negative vote on any proposed interpretation, the interpretation shall be referred to the full committee having primary jurisdiction. Where one committee reports through another committee only the initiating committee need be consulted, and the interpretation shall be issued on the basis of a majority vote.

(e) Interpretations, when issued, shall be transmitted to the submitter and to the NFPA office for publication.

(f) Interpretation procedures shall be established and conducted under the direction of the committee and shall be reported to the NFPA annual meeting when established.

(g) Committees shall consider interpretations in connection with the next revision of the standard in ques-

tion with a view to determining whether any change may be desirable in the interest of clarity.

(h) No committee shall be under any obligation to process requests for interpretations at any specified time, nor to issue interpretations except at its own convenience.

15. It was voted to thank the various individuals who have volunteered to serve on the Committee on Electronic Computer Systems for their offers of service, and to inform them that the committee is already sufficiently large for efficient operation so that additional appointments are not appropriate at this time.

Committee Appointments

16. Various appointments to technical committees recommended by the Committee on Technical Committee Procedure and other appointments to nontechnical committees were confirmed. The Technical Advisory Committee was granted authority to act on other committee appointments prior to publication of the 1960 Year Book which will list all committee members subject to confirmation by the Board at its next meeting. All other committee members were reappointed for the year 1960–61 with the exception of those who have died, resigned, or have been dropped because of their apparent lack of interest in committee activities. (The 1960 Year Book will include a complete list of committee personnel.)

Other Business

17. The Technical Advisory Committee for 1960–61 was appointed as follows: T. Seddon Duke, Chairman, Warren J. Baker, A. L. Brown, Everett W. Fowler, Paul C. Lamb.

18. Mr. Moulton reported on the technical standards of the Association and presented some 35 new standards which had been printed as a result of the Annual Meeting in Montreal. The Board expressed approval of the expeditious handling of this matter.

19. Mr. Moulton reported on the Building Research Advisory Board activity on fire safety in schools, indicating a sense of frustration at the lack of constructive accomplishment. This was discussed by Mr. Baker, Mr. Bond, Mr. Bugbee and others.

20. Mr. Bugbee reported on NFPA activities with respect to dwelling fires, displayed a large assortment of NFPA literature on this subject, and referred to the fine work of the fire chiefs in promoting the inspection of dwellings in the interest of fire safety. Mr. Thomas discussed the campaign of the International Association of Fire Chiefs and reported on Governors' Conferences on fire safety which have now been held in the great majority of the states with a very beneficial effect.

21. It was voted to hold the next meeting of the Board at the Union League Club in New York on Thursday, January 19.

22. A communication was received from a fire chief in Chile who appealed for help in a situation following the earthquakes in his country. This was discussed with expressions of sympathy for the chief and approval of the publication of his letter in *Fire News*.

Tucson, Arizona — 1959 Fire Experience

In the April 1960 QUARTERLY, page 433, the building fires per 1,000 population in Tucson, Arizona, during 1959 were reported as 6.7. In determining this figure, the 1950 U. S. census population estimate of 45,000 was used. Chief J. H. Freeman has advised us that the 1959 Tucson population was 182,000. Using this estimate, the building fires per 1,000 ratio are 1.6.

Good Business — This

There is a growing realization among industrial operations of all types and sizes that a comprehensive program of fire prevention and protection is good business.

Today's inflated replacement costs place a premium on safeguarding existing plant and equipment. Today's highly competitive economy makes any extensive production interruption a possibly crippling event in the life of a business, with its accompanying losses of customers and employees.

Perhaps there is increasing awareness that, as evidenced by the National Fire Protection Association's annual study of large loss fires, relatively simple protective measures may be the means of keeping a minor fire from growing into a major disaster.

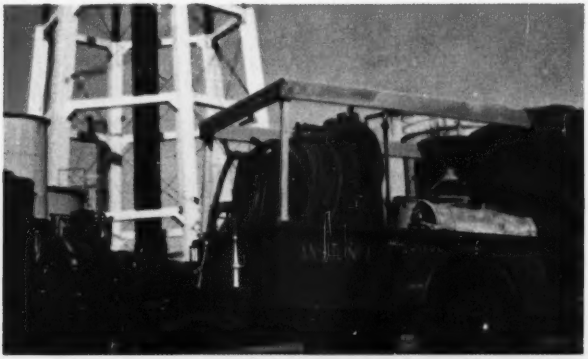
Reports of current developments in industrial fire protection and prevention reach NFPA each year as entries in the annual Fire Prevention Contest. They come from all over the United States and Canada, from large and small companies, from operations which range from auto and missile manufacturing to transportation and warehousing.

Among the top industrial entries in the 1959 Contest was one from Ivorydale, a major production facility of the Procter and Gamble Company in Cincinnati and St. Bernard, Ohio.

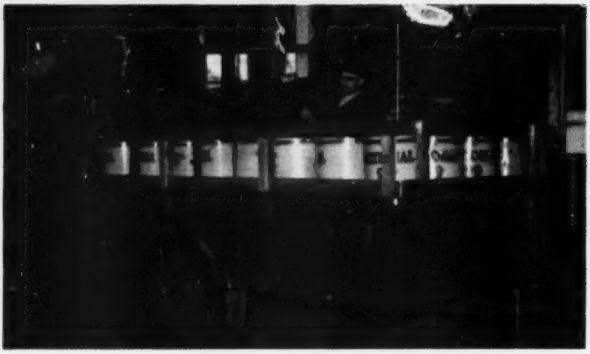
This picture story is an excellent example of a progressive industrial fire safety program. The photographs, originally appearing in its 1959 contest entry, have been reproduced with the permission of the Company.

The Ivorydale plant of the Procter and Gamble Company consists of 163 acres of ground on which there are 134 buildings.

This pumper carries 450 gals. of water and two 225-ft. hose reels, 350 lbs. of high pressure CO_2 with 250 ft. of hose, a motor generator set, two flood lights, assorted power tools, short ladders, and first aid fire extinguishers.



This trailer, which carries two 300-lb. dry chemical fire extinguishers, a complete recharge for each, and a large asbestos blanket, can be towed by any one of five fire emergency trucks.



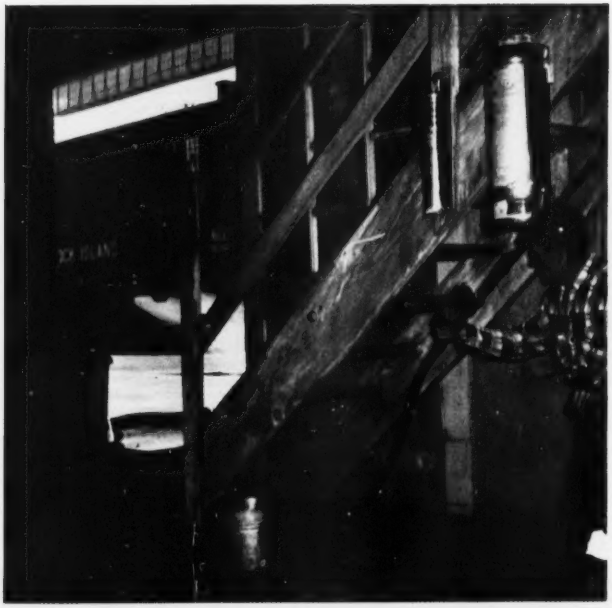
One of the four 1½-ton foam trailers placed at strategic locations throughout the plant adjacent to flammable liquid and solvent hazards.

This electric fire pump, which starts automatically whenever the pressure in the fire mains falls to 50 psi, has a capacity of 1,500 gpm at 100 psi and is located in the plant reservoir which has a 1,500,000 gal. capacity.

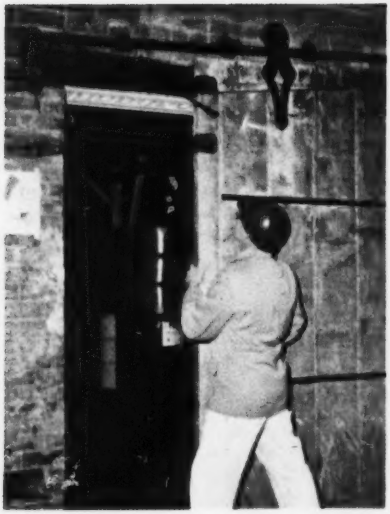
◀This water tower has a capacity of 300,000 gals. at overflow. A pressure of 61 psi is maintained on the plant's underground mains.

This new gasoline driven fire pump has a capacity of 1,500 gpm at 100 psi and operates automatically.

◀ One of two 1,000 gpm, manually operated, steam-driven fire pumps. Tests run each week develop full pressure in the underground fire mains and slippage tests are run yearly. Slippage over 15% requires repairs.



There are 125 sprinkler systems in the Ivorydale plant which undergo a rigid systematic inspection. By following such a maintenance program, the plant is assured of maximum sprinkler efficiency.



The 721 fire doors in Ivorydale are inspected twice each week for condition, proper operation, and obstructions. Once each year the fusible link of each door is disconnected to determine if the door will close tightly.

At the fifth anniversary of purchase and each five years thereafter, each soda acid, cartridge type, foam, and pressurized extinguisher is tested hydrostatically. Safe practices are important in conducting these tests.

The men of the plant's Central Fire Department participate in 4 hours of intensive drill each month. Shown here is the extinguishment of a combination tank and flammable liquid spill fire using both high and low pressure water fog.

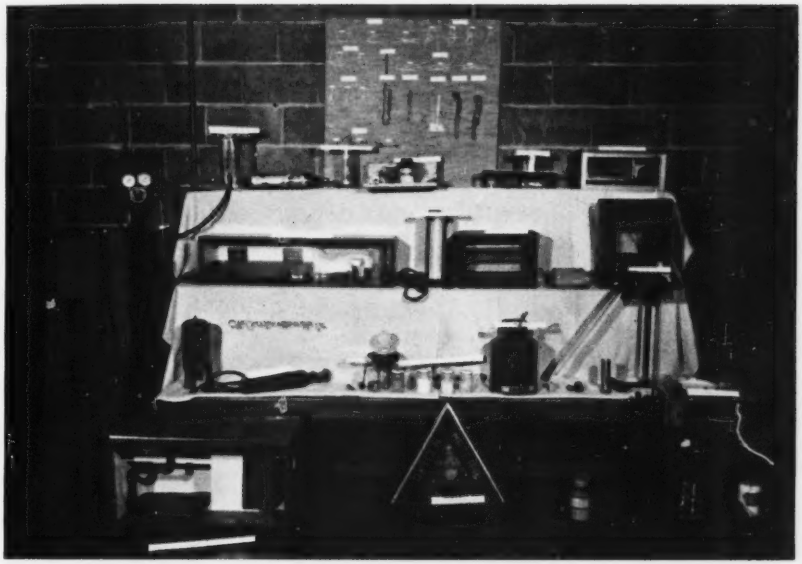
A training drill for the plant firemen using chemical foam to extinguish a flammable liquids spill fire.

Gaining confidence in and learning techniques on the use of dry chemical for extinguishing a flammable liquids fire in an open-top tank.

The proper inspection for and the issuing and approval of welding permits is a vital part of the fire prevention program at Ivorydale. Here the Fire Chief tests the atmosphere inside a tank, located in a hazard area, for explosibility.

An employee of the Prepared Mix Department extinguishing an excelsior fire under the supervision of the Fire Marshal using a soda-acid extinguisher.

The larger part of the Ivorydale Plant is located in the city of St. Bernard, Ohio. Here Chief Fisher and the day firemen examine an alteration in the processing equipment at the Fatty Alcohol Plant No. 2 under the guidance of the Ivorydale Fire Chief.



In the training of fire brigades, supervisory personnel, contractors, and hourly employees, much use is made of visual aids. These aids cover the entire range of the fire protection equipment in the plant and the nature of the fire hazards encountered.

Early in Fire Prevention Week, Johnny Mims put on a Sparky hat and sweater to make a "formal" inspection of the Ivorydale Fire Department equipment and crew.

In an evacuation drill, the employees from the upper floors of the Crisco building leave the building by the fire escape at the rear.

An employee receives her award for her prize winning slogan: "Fires need four things to ignite: Air, fuel, spark, and no foresight."

Fiberboard Fire in Modern School

By Lawrence R. Woltz

Fire Marshal, Prince George's County, Maryland

At 10:50 P.M., March 23, 1960, the fire sirens of the West Lanham Hills Fire Department sounded the beginning of another chapter on the burning characteristics of combustible fiberboard acoustical tile. The fire to which this Maryland Department was responding involved a modern noncombustible elementary school building that was furnished with typical modern school furniture and finished mostly with noncombustible interior finish. The principal exception to noncombustible interior finish was the ceiling of combustible fiberboard acoustical tile mounted on wood furring strips in the classrooms and corridors. Other exceptions were the wooden doors and wood trim on doorways, windows, and walls.

In this fire, as in previous fires involving combustible fiberboard acoustical tile, there were other factors (such as lack of cut-offs) that contributed to the extent of fire spread. But, also, like these other fires, it was the combustible fiberboard that provided the surface for rapid flame spread.

The School Building

The West Lanham Hills Elementary School was an 18,500 sq. ft. 1-story, "L"-shaped building containing 8 classrooms in one wing (see Figure 1), and, in the other, a library, auditorium, clinic, kitchen, boiler room, cafeteria, teachers' room, principal's suite, and sundry storage areas. The building was placed in service in 1953.

The classroom wing consisted of four classrooms on each side of a central 8 ½-foot-wide corridor. Each classroom was provided with a direct exit door to the outside of the building. These exit doors were equipped with panic hardware and were in addition to the classroom doors leading to the corridor. Between each classroom and the corridor was a 6 ½-foot-wide classroom utility area. This utility area contained a toilet, wash basin, coat room, storage closet and display case.

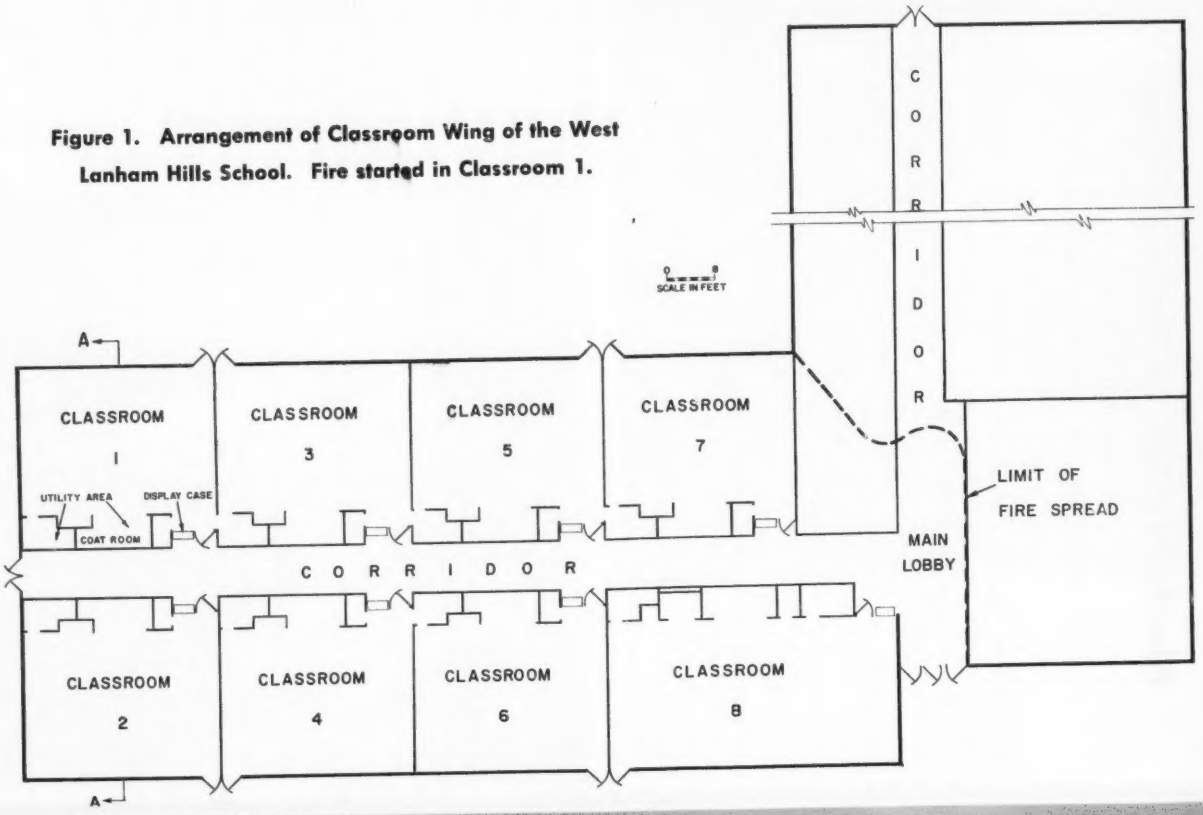
Over each classroom was a metal roof deck supported on light open-web steel-bar joists on light steel trusses, beams, and columns. Wood furring strips were wired to the bottom of the classroom joists, and combustible acoustical tile was fastened to these (see Figure 2).

The classroom ceiling sloped down from the high point over the utility-area partition to the low point at the outside wall. The flat roof over the corridor and utility area was also a metal deck but was located 6 feet below the utility-area edge of the classroom roof. A 4-foot portion of the classroom wall that extended above this flat roof was constructed of glass blocks thus creating a continuous skylight into each room. The short exterior wall above the glass blocks was metal-covered plywood paneling.

The classroom wall below the glass block skylight was finished with

The understanding help of Ronald S. Senseman, architect for the original and rebuilt school building, is greatly appreciated.

Figure 1. Arrangement of Classroom Wing of the West Lanham Hills School. Fire started in Classroom 1.



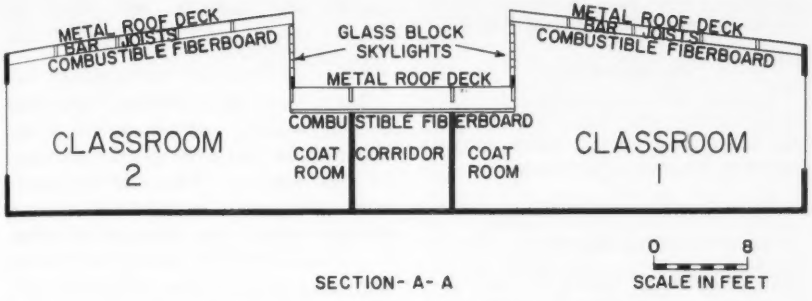


Figure 2. Section Diagram of Classroom Wing.

cement-asbestos board panels down to the utility-area partitions (see Figure 2). Here wood furring strips were wired to light metal bars to form a base for the ceiling of combustible acoustical tile over the corridor-utility area. The partitions in the utility area and those separating it from the corridor were 4-inch concrete block and they extended up to the corridor-utility area ceiling, but did not extend above it. Partitions between the classrooms, also of 4-inch concrete block, extended up to the bottom of the roof trusses but did not extend above them.

Ceiling Concealed Spaces

This construction created three concealed ceiling spaces. Two ran the length of the wing over the classrooms, one space above the four classrooms on each side of the corridor. The other concealed space ran the length of the wing above the corridor-utility area. Though these hidden spaces were not physically interconnected, they were separated, from a fire standpoint, only by combustible fiberboard acoustical tile ceilings.

Doors to classrooms from the corridor were equipped with wired glass lights, but these doors were located next to display cases which had plain glass fronts and backs which negated whatever fire resistance the doors possessed.

The metal roof deck covering was a mopped coating of asphalt with a 1-inch layer of insulation board set into the asphalt and a built-up roof forming the weather surface over the top of the insulation board.

The Building Exits Code

The West Lanham Hills Elementary School building would fall into the "Group A" classification (one-story building) of Section 22 (Educational Occupancies) of the 1960 edition of the Building Exits Code, NFPA No. 101. With a "Group A" building the following recommendations pertinent to this fire apply:

Interior Finish

Paragraph 2216: Interior finish in interior corridors shall be Class A or Class B and may be Class C elsewhere.* . . .

Paragraph 4441: Interior finish not in excess of 10 per cent of the aggregate wall and ceiling areas of any room or space may be Class C materials in occupancies where interior finish of lower flamespread rating is required.

Wall Openings

Paragraph 2217: Walls separating rooms from other rooms or enclosed corridors shall have

*Interior finish is judged by its flamespread rating as obtained by "Method of Test of Surface Burning Characteristics of Building Materials" (tunnel test), NFPA No. 255, in which asbestos-cement board rates 0 on the scale and red oak lumber rates 100. Class A is a flamespread between 0–25, Class B (25–75), Class C (75–200).

no openings except doors and any glass between rooms and corridors shall be fixed wired glass.

Concealed Spaces

Paragraph 4371: In new construction of combustible materials, all hollow spaces in walls, floors, or ceilings through which fire might spread shall be effectively fire stopped. . . .

Paragraph 4372: Unoccupied attic spaces under roofs of combustible construction and above combustible ceilings of occupied spaces shall be subdivided by partitions to form subdivision not to exceed 3,000 sq. ft. area in each, unless the attic is sprinklered . . . or the ceiling construction beneath the attic has at least a one-hour fire resistance. . . .

The Fire

Sometime after the school had closed for the day at 5:00 P.M. Wednesday, March 23, 1960, a person or persons unknown forcibly entered Classroom 1 of the building. It appears that he (they) shoved the wood-topped metal desks together and piled on this now-large wooden surface various combustible materials at hand, such as books, papers, and manuals. He (they) set fire to this pile of combustibles and departed.

Prince George's County Fire Marshal's Office

The rubble found in Classroom 1, where the fire was started. The classroom had conventional school desks and chairs with wooden tops and chair sets. The person(s) starting the fire also gathered combustibles (books, papers, etc.) to create fuel for the incendiary act.

There was no automatic sprinkler system to detect and extinguish the fire nor any automatic fire detecting system to give warning. Thus the fire burned unnoticed for an estimated half hour. Flames ignited the combustible fiberboard acoustical tile ceiling and burned across its surface. The fire burned into the concealed space above the tile and raced down the space over Classrooms 3, 5, and 7.

The fire entered the concealed space over the corridor probably by burning up through the combustible acoustical tile ceiling of the utility area. Once inside this space flames raced above the corridor ceiling the length of the corridor and into the high main lobby area at the end of the corridor in the other wing (see Figure 1). Fire broke into the classrooms on the other side of the corridor, burned up into the concealed ceiling space over these even-numbered classrooms and raced the length of this side of the wing.

Chance discovery by a neighbor brought fire fighters following the telephoned alarm at 10:50 P.M. Firemen found flames leaping from the windows and from the paneled wall area above the glass block skylights of Classrooms 1 and 3, and flames were visible in Classroom 2 and in the main lobby.

Attack on the fire was made from the exterior of Classroom 3, Classroom 2, and the main lobby. Ten 1 ½-inch lines and four 2 ½-inch lines were used. These lines were advanced into the building as quickly as the rooms were cooled sufficiently to permit entrance. Self-contained breathing apparatus was required for about one hour before smoke could be removed.

The Damage

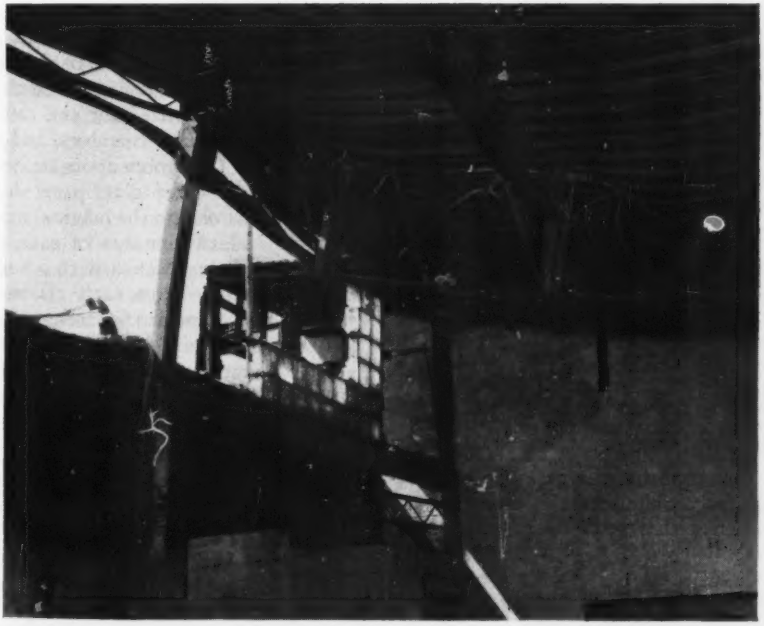
Heat had warped the metal roof deck and the light steel construction so badly that the classroom wing has been razed and is being rebuilt. The expanding steel caused cracking of the concrete block partitions in places, and the wiring and plumbing in the wing were ruined. The damage to the $241,000 structure will exceed $179,000.

The loss of this building to the school system meant that the eight classes of 280 children had to be hauled by bus to other locations. This transportation was expensive and inconvenient as it required two additional buses to those already in use.

Fortunately two school libraries, a school music room, and a classroom scheduled for use as an office were available to complete the children's school year. The three schools with this space available ranged 1¼ miles to 2¾ miles from the original school site, requiring some children to be transported past closer schools to their temporary classrooms.

Conclusions

It is true that this building was basically noncombustible in its construction, but there was a 7-ton combustible ceiling (4½ tons of combustible acoustical tile supported by 2½ tons of furring strips) in the classroom wing alone. Also in the classrooms there were wood trim, wooden doors, and other combustible interior finish totaling over 2¼ tons, and there were desks, tables,



Prince George's County Fire Marshal's Office

The metal roof deck, unprotected columns, trusses, and joists shown exposed after flames devoured the combustible fiberboard acoustical tile ceiling.

Prince George's County Fire Marshal's Office

Post-fire view of the corridor in the classroom wing taken opposite Classroom 1. Here again the fiberboard ceiling and furring strips to which the tiles were attached have been consumed.

chairs, books, and other combustible contents totaling close to 2¼ tons. Thus the noncombustible classroom wing of the school held over 11½ tons (23,000 pounds) of combustible material available to burn. The asphalt coating on the roof of the classroom wing weighed an estimated 2,250 pounds.

Because of the ease of flamespread across the surfaces of the combustible acoustical tile and because of the nonfirestopped concealed ceiling spaces, the fire spread on the tile to each corner of the classroom wing of the building. This rapid flamespread ignited much of the wood framing, trim, and contents.

It is true that the gases from the vaporizing asphalt of the mopped coating over the metal deck, which were forced into the building, added fuel and heat. The burning of these gases was a factor in the extent of building damage, but not a factor in the initial flamespread.*

It is also true that the combustibles piled in Classroom 1, the wood furring strips, the desk tops, and the trim in the rest of the wing helped the fire do a little more in a little less time, but this did *not* alter the total outcome of the fire. The fact remains that the West Lanham Hills Elementary School was so badly damaged by flamespread over combustible fiberboard acoustical tile that the school had to be abandoned for the remainder of the school year.

The Reconstruction

The building is now being reconstructed. Metal lath and plaster tops of the classroom-to-classroom and the classroom-to-corridor partitions are being run up to the underside of the roof. Noncombustible acoustical tile on metal strips is being utilized for the ceiling finish of classrooms, corridors, and the utility area. Classroom doors are being replaced with wired glass panel doors similar to the ones in the original building. The classroom side of each display case is being backed with a 4-inch masonry wall. Thus each classroom will become a separate fire area, and the combustibles available to burn will be greatly reduced. The West Lanham Hills Elementary School is being rebuilt in 112 days as a more life-safe, property-safe building.

*See "Insulated Metal Roof Deck Fire Tests" by J. A. Wilson, Factory Mutual Engineer; NFPA QUARTERLY, Oct. 1955, page 92 (Test 5).

Handling Cryogenic Fluids

By R. M. Neary

Linde Company, Division of Union Carbide Corp.

Cryogenics can be defined as the science and technology of producing and using ultralow temperatures, usually from minus 148° F to almost absolute zero (−459° F). Increased use of cryogenic fluids, such as liquid oxygen and liquid hydrogen in the rocket and missile industry coupled with the publicity which attends that industry, has brought them to the attention of the general public.

Sketch of History

The handling of cryogenic fluids in large volumes, however, is not new. Liquid oxygen has been shipped commercially for a quarter of a century and is by far the largest volume cryogenic fluid handled. Liquid nitrogen and argon have been transported in tank trucks for several years, liquid helium more recently. Liquid methane has been transported by ship from the United States to England. Liquid hydrogen has been shipped by tank truck for a few years. Larger volumes will be handled in the future because of its increased use as a rocket propellant.

Character of Cryogenic Fluids

These gases, which are the common cryogenic fluids, cannot be liquefied at atmospheric temperature regardless of the pressure. They must be refrigerated to a very low temperature to liquefy them. Cooling or refrigerating a liquid reduces its vapor pressure and reduces the pressure in the container. In handling cryogenic fluids it is common practice to maintain the liquid a few degrees above its boiling point at one atmosphere so the pressure in the container is usually less than 100 pounds per square inch.

Self-refrigeration Basic Principle

Low temperature is maintained by self-refrigeration; heat transmitted into the liquid vaporizes a small part of it while the residual liquid remains at essentially constant temperature. When a refrigerated liquid product is placed in a well insulated tank, heat from the atmosphere, which is several hundred degrees warmer than the product, leaks through the insulation causing some liquid to vaporize and the pressure in the container to rise very slowly. When the pressure in the container reaches the setting of the pressure control device, vapor is released which maintains the liquid at a constant low temperature.

This may be illustrated by a household pressure cooker placed over a low flame. The low heat into the water vaporizes some of it and the pressure gradually builds up to the setting of the spring loaded relief device. At this point steam is released to the room and the temperature within the container remains constant, at say 240° F.

Recondensing of Vapor

The same process is used to self-refrigerate cryogenic fluids except it functions at 500° F to 600° F lower temperature. With some large refrigerated liquefied petroleum gas and ammonia tanks, the released vapor is recondensed, sub-

Based on an address by the author presented at the 64th NFPA Annual Meeting held May 16 20, 1960, Montreal, Quebec, Canada.

cooled, and fed back into the tank to supply refrigeration. This is mentioned only to distinguish this type of external refrigeration from the self-refrigeration used with cryogenic fluids.

Construction of Containers

Storage and transportation containers for cryogenic liquids are well insulated jacketed vessels resembling oversize thermos jugs. The liquid container or pressure vessel is fabricated of materials suitable for the low temperatures involved (i.e. stainless steel, aluminum, copper alloys, etc.). Carbon steel is brittle at these low temperatures. Piping, supports, and other appurtenances connected to the liquid container are likewise of materials suitable for the low temperatures encountered. The liquid container is supported within an outer jacket, usually of carbon steel, by rods or tubes having low heat conductivity properties to prevent heat transfer from the atmosphere to the liquid.

Insulation of Containers

The space between the outer jacket and the liquid tank contains noncombustible insulation and in most instances a very high vacuum (1/100,000 of atmospheric pressure) is maintained. Recent improvements in vacuum pumps and insulating materials have made it possible to produce better vacuums and thinner insulations with excellent insulating properties. As a result, even liquid helium, the coldest known liquid, boiling at 4° C above absolute zero, can be stored in a cryogenic tank of this type.

The perlite powder or glass wool-aluminum laminate insulations used on cryogenic tanks are far superior to the insulations, such as cork, used on lagged tanks. The thermal conductivity of a typical powder-vacuum insulation (6 inches thick) is about 0.002 British thermal units per hour per square foot per degree Fahrenheit (Btu/hr/sq ft/°F), whereas heat transfer through 4 inches of cork is about 0.075 Btu/hr/sq ft/°F. Thus typical powder-vacuum insulation is approximately 35–40 times more effective than four inches of cork, and there are better insulations than powder-vacuum.

Overpressure Safety Devices

The liquid container is usually protected from overpressure by two safety devices connected to the vapor phase; a relief valve set at or below the design pressure of the container and a frangible disc set to function at a somewhat higher pressure. Although very unlikely, should the vessel be exposed to severe fire or the relief valve stick, the frangible disc would function and blow the tank down to atmospheric pressure. In sizing the relief devices to prevent overpressure in a vessel subjected to fire, it is assumed that the vacuum is lost and that the insulation space is filled with the contents of the container (gaseous phase) at one atmosphere. The insulation space is protected from overpressure by a safety device in the casing usually set to function at a few pounds positive pressure.

Containers are filled to a certain point by weight or by testing for liquid level with a valve installed at the desired filling level so the container will not go liquid full before the pressure reaches the setting of the relief valve. Thus, the safety devices vent only gaseous product, not liquid.

Typical Container Design

The Linde LC–3 container shown in Figure 1 for liquid oxygen, nitrogen, or argon is a good illustration of many of the above points. It is built to Interstate Commerce Commission Specification 4L, having a stainless steel liquid container and carbon steel jacket. The liquid container is supported by a

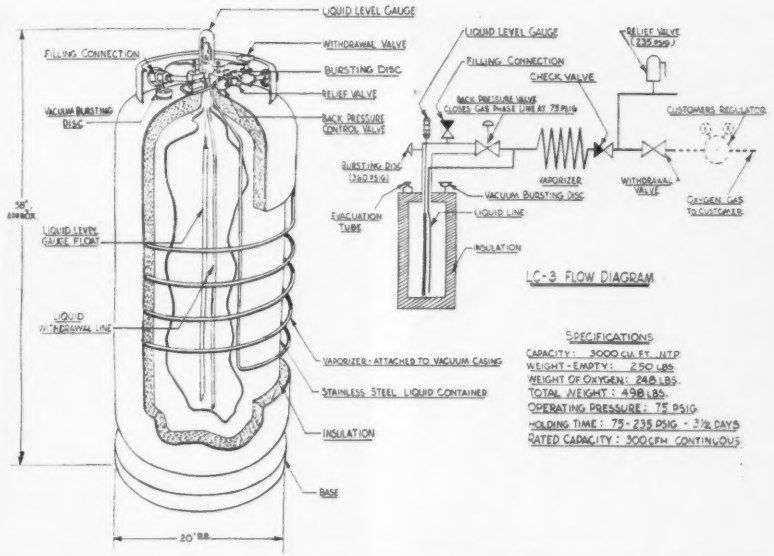


Figure 1. This Linde LC-3 container for liquid oxygen, nitrogen or argon is built to Interstate Commerce Commission Specification 4-L and normally operates at 75 pounds per square inch. It is protected by a safety valve and a frangible disc.

special alloy steel tube having low heat-leak properties.

The vessel normally operates at 75 pounds per square inch (psi), is protected by a 235 psi safety valve and a 360 psi frangible disc.

One cubic foot of liquid oxygen at atmospheric pressure when evaporated and warmed to atmospheric temperature will produce about 862 cubic feet of gaseous oxygen. This vessel carries the gaseous equivalent of 12 high pressure cylinders while occupying about ⅛ of the floor area and weighing ¼ as much (a weight saving of over ½ ton). It is about the same size and weight as a 55-gallon drum and can be moved with the same ease.

The vessel will stand several days with no withdrawal and no release of gas because of the unusually good insulation, the conductivity of which is about 5×10^{-4} Btu/hr/sq ft/°F. This is about ¼ the value for powder-vacuum insulation mentioned previously or about 150 times better than 4 inches of cork, and this special glass fiber-aluminum laminate insulation is less than 3 inches thick!

Only gaseous product can be withdrawn from this container for it has its own built-in vaporizing coil. (On larger tanks the vaporizer is usually external, being located adjacent to the tank.) If the cylinder is above the normal operating pressure of 75 psi, withdrawal from the cylinder is in the gaseous phase through the open back-pressure valve which reduces the pressure in the container. At 75 psi, the back-pressure valve closes and the withdrawal will be in the liquid phase to the vaporizer coil. During periods of no withdrawal, the pressure slowly rises above 75 psi. It takes 4 to 5 days for the pressure to reach the setting of the 235 psi relief valve. At this point,

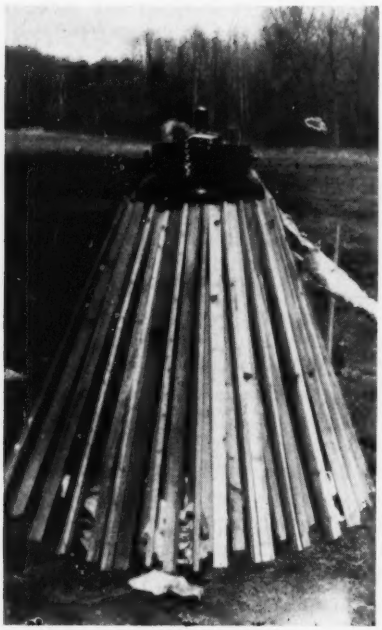


Figure 2. Set-up for the bonfire test to determine the behavior of the LC-3 cylinder under fire conditions.

Figure 3. Condition of the container after the bonfire test. The casing reached 1800°F, but the pressure never exceeded 235 psi.

the cylinder would vent only 2 to 3 cubic feet per hour.

This container has been subjected to several tests to assure safety under all conditions of operation. One of these was a bonfire test involving a wood fire. Figures 2 and 3 show the container before and after the test. The casing temperature reached 1800° F but the pressure never exceeded 235 psi and the vessel still contained over 50 per cent of the product when the fire was over.

Over 8,000 of these containers are in service. A few have been subjected to severe fires and the reports indicate that low-pressure, well-insulated containers represent less hazard when involved in a fire than conventional high pressure cylinders which have long been recognized as relatively safe containers.

Transportation of Cryogenic Liquids

Linde started tank truck shipments of liquid oxygen in 1932 (see Figure 4). Last year approximately 400 trucks with individual capacities ranging from 5 to 20 tons traveled more than 12 million miles. Total truck mileage since 1932 is estimated at 175 million miles. Our tank car shipments of liquid oxygen originated in 1939. Last year approximately 500 tank cars operated in excess of 10 million miles with each car carrying approximately 40 tons of liquid oxygen. Over the past several years we have shipped substantial quantities of liquid nitrogen and liquid argon. For the past three years we have been shipping liquid hydrogen and liquid helium in LC–3 type containers.

An excellent safety record has been compiled over the years with the trans-

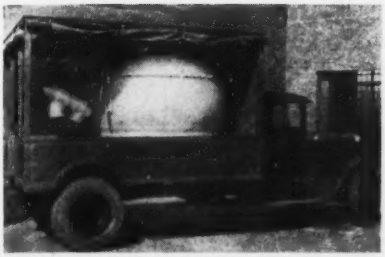


Figure 4. Tank truck shipments of liquid oxygen started in 1932. Last year Linde alone operated 400 trucks more than 12 million miles.

portation of liquid oxygen and other cryogenic liquids. Our liquid oxygen tank trucks have been involved in the normal expectancy of highway accidents, including tire fires. Our tank cars have been involved in normal expectancy of derailments and other railroad accidents. Some of them have been badly damaged, but in no case has the cryogenic liquid significantly contributed to the magnitude of the damage.

To the best of our knowledge, all private producers of cryogenic liquids own and operate their own trucks. The drivers are well trained and experienced in the operation of the trucks and the properties of the materials being handled. The Compressed Gas Association, whose membership includes most private cryogenic liquid producers, has a Committee on Cryogenics that is preparing suggested specifications for tank trucks for those cryogenic gases that are regulated by the ICC.

Cryogenic liquids are pumped and handled in much the same manner as water except that the pumps and containers are well insulated (see Figure 5). These liquids are normally transferred from the transport equipment to the storage tank by connecting a single pipe

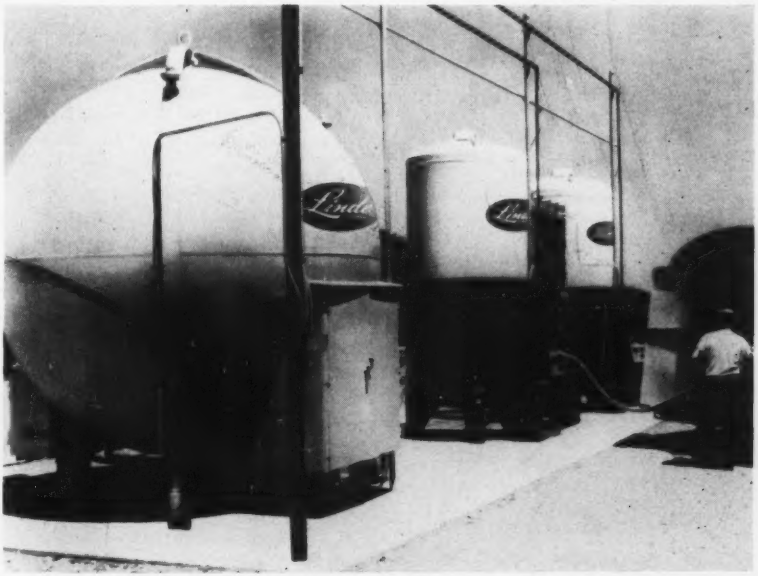


Figure 5. Cryogenic liquids are pumped from transport equipment to storage tanks much the same as water except that the pumps and containers are well insulated.

or hose to the liquid phase of the transport container. Pumps are used to transfer the liquid if the pressure in the receiving container is much above atmospheric pressure. If the storage tank operates at essentially atmospheric pressure, the transfer of liquid is often made by building a small amount of pressure in the transport vessel.

Customer Storage

Customer storage tanks range in capacity from 25,000 cubic feet (220 gallons) to 10 million cubic feet (86,700 gallons). (The capacity of a tank is usually expressed as equivalent cubic feet of gaseous product at 70°F and one atmosphere.)

A typical liquid oxygen installation at a hospital is shown in Figure 6 and would include a 90,000 cubic foot (800 gallon) storage tank operating at approximately 80 psi. A bank of high pressure cylinders containing approximately one day's supply of oxygen is held in reserve to supply the pipeline in the event of any malfunction of the liquid supply unit. This is a requirement of the NFPA Standard on Nonflammable Medical Gas Systems (No. 565).

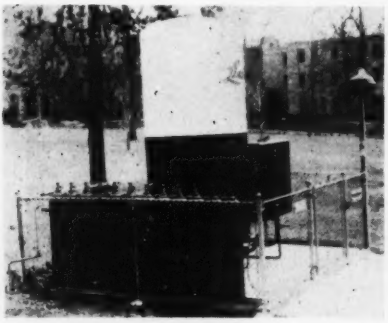


Figure 6. Typical liquid oxygen installation for a hospital. This tank holds 90,000 cubic feet of the gaseous product at 70°F, and one atmosphere.

Liquid oxygen storage tanks at industrial sites are similar to hospital units except that a reserve supply of high pressure gas is not provided. Also the size of the units usually exceeds the capacity of a hospital unit. In most cases, there is no loss of product or venting from the container. Venting might occur when the unit is shut down for an extended period of time, such as a vacation in an industrial plant or when the product is used as a liquid, as in the missile industry.

Storage tanks at our mass production plants have capacities up to 75 million cubic feet. These tanks normally operate at 2 to 5 psi.

Location of Storage Tanks

In determining site locations for cryogenic tanks, it is advisable to consider the properties of the materials as well as the construction of the tanks. Liquid oxygen, nitrogen, and argon, which are the large volume cryogenic liquids handled today, are all nonflammable, nontoxic and odorless. However, oxygen supports combustion. Ignition of combustible materials may occur more readily in an oxygen enriched atmosphere than in air, and combustion proceeds at a faster rate although no more total heat is released. The boiling points of cryogenic liquids are so low that they evaporate quickly when released to the atmosphere, like water on a hot stove. Thus the primary considerations in locating cryogenic storage tanks are to place them away from potential fire exposure and provide adequate ventilation.

The NFPA Standard on Bulk Oxygen Systems at Consumer Sites (No. 566) covers the locations of liquid oxygen tanks. It also may be used with discretion as a guide for liquid nitrogen and argon tanks. This pamphlet states "these standards therefore, provide pri-

marily for protection of the bulk oxygen system from involvement by fire from sources apart from the system itself." It further recommends that oxygen systems near aboveground flammable or combustible liquid storage which may be either indoors or outdoors be located on ground higher than the flammable or combustible liquid storage. Where it is necessary to locate a liquid oxygen tank on ground lower than the adjacent flammable or combustible liquid storage, suitable means shall be taken (such as diking, diversion curbs, or grading) to prevent accumulation of the flammable liquids under the bulk oxygen system. Tanks should be placed on noncombustible foundations and supports. Furthermore it is desirable to have the area between the back of the cargo truck and the storage unit surfaced with crushed rock or concrete.

Fortunately all cryogenic liquids have a built-in warning device that appears whenever liquid is released to the atmosphere (see Figure 7). Except in extremely dry localities, the cold liquid immediately condenses moisture in the air creating a fog which normally extends over an area larger than the area containing an appreciable amount of the released gas. In the case of oxygen, the concentration at the outer edge of the fog would not exceed that in normal air by more than a per cent or so. In testing liquid hydrogen it has been shown that the fog area extends far beyond that area containing a combustible mixture.

Liquid Hydrogen

Liquid hydrogen is presently being produced and handled in large volumes primarily for use in rockets and missiles. Liquid hydrogen is transparent, odorless, and only one-fourteenth as heavy as water. It boils at minus 423° F at 1 atmosphere. Its temperature is so low that oxygen from the air will condense

Figure 7. Whenever liquid is released from a cryogenic storage tank, the cold liquid condenses moisture in the air creating a fog (as shown above) which normally extends over an area larger than the area containing an appreciable amount of the released gas.

in the liquid and solidify. This solid oxygen may lodge in valves or other restricted places, creating a potential explosion hazard. For that reason, all air must be purged from a vessel before admitting liquid hydrogen.

One gallon of liquid hydrogen will convert to about 115 cubic feet of flammable gaseous hydrogen. Except for very small quantities, liquid hydrogen should be stored and handled out of doors in a ventilated area. The Air Force, under an Air Research and Development Command contract, has had the properties of liquid hydrogen and the effects of large volume spills thoroughly investigated. Results of these tests have been declassified by the Air Force. After examining the data from these and other tests, experts have concluded that liquid hydrogen is not as hazardous to store and handle as a corresponding quantity of liquefied petroleum gas or turbine fuel. Radiation from a hydrogen flame is only a fraction of that from a propane flame and the peak emissivity lasts for only a few seconds with hydrogen as compared to minutes for an equal quantity of propane.

As yet there are no industry standards for the location or spacing of liquid hydrogen tanks. In light of the above tests and experience to date, it appears reasonable to use the standards for liquefied petroleum gas and highly flammable liquids as guides for location of liquid hydrogen tanks. The jacketed insulation will help to protect tanks subjected to fire exposure. Liquid hydrogen tanks should be located away from buildings and walls so as to avoid the confinement of any vapors that may be released.

Linde has been transporting liquid hydrogen in portable containers in open trucks from our plant at Tonawanda, New York, for approximately 3 years. Liquid hydrogen shipments are covered by ICC special permits since the regulations presently prohibit the shipment of liquid hydrogen. In July 1960 Linde expects to have its large capacity liquid hydrogen plant located at Torrance, Los Angeles County, California, on stream. This plant will produce approximately 6 tons (20,000 gallons) of liquid hydrogen per day. The product will be stored at the plant in a sphere having a capacity of about 40,000 gallons. The liquid hydrogen will be transported in 7,800-gallon semi-trailers similar to those used for liquid oxygen except that improved insulation is used. An unusual feature of these trucks is that the tare weight of tractor and trailer is 44,000 pounds, while the weight of liquid hydrogen lading is only 4,600 pounds. Government agencies are transporting liquid hydrogen by tank truck, and to the best of our knowledge, there have not been any incidents.

Conclusion

I have pointed out that the handling of cryogenic liquids is not new, although products such as liquid hydrogen are being handled in much larger volumes. Our record shows that these products may be handled safely. To do so, it is only necessary to understand the properties of cryogenic liquids and take steps to guard against unreasonable hazards.

Cryogenic Container Caused '44 Catastrophe

Acme

Failure of a cryogenic liquefied natural gas storage container at Cleveland, Ohio, on October 20, 1944, killed 136 people and caused $6,000,000 damage.

The natural gas was stored as a liquid at minus 270° F and at 2¾–3 pounds per square inch. The storage container consisted of a 76-foot-diameter cylindrical outer shell with a 70-foot-diameter inner cylindrical container constructed of 3.5 per cent nickel steel. The 3-foot space between the two shells was filled with mineral wool insulation. Probable cause of the container failure was the use of materials of construction inadequate for low temperature cryogenic storage.

Burning liquid and vapor spread so rapidly that many of the victims did not have time to try to escape. Most of the gas company's property, 79 dwellings in an adjoining residential area, and approximately 200 automobiles were destroyed. Many other dwellings, two factories, eight mercantile properties, telephone, light, water, and sewer distribution systems were severely damaged. Arrow indicates location of the tank that failed.

Design of cryogenic natural gas storage containers as discussed in the previous article by Mr. Neary is believed to have eliminated the construction weaknesses responsible for the Cleveland disaster.

Controlling Chemical Process Reactions

By W. H. Doyle, Chemical Engineer

Factory Insurance Association

Chemical processes are of two basic types. One requires heating because the reaction absorbs heat. Safeguards for *heat absorbing* processes require only that the source of heat present a minimum hazard and, under conditions where overheating or too prolonged heating could be troublesome, that some form of effective emergency protection be provided. The second basic type of chemical process releases heat during the reaction. Safeguarding *heat releasing* processes is complicated by the need to provide for the sudden release of large quantities of heat due to improper mixing of reactants.

This article discusses the principles involved in designing safety into both heat absorbing and heat releasing processes.

Processes Requiring Heat Input

As an illustration of a process requiring input of heat, consider the distillation of a flammable liquid as a product, a by-product, or as a carrier that has to be recovered. Distillation is a simple operation. It was probably invented to make brandy from wine. When alcohol is distilled, one gallon of liquid changes to about 750 gallons of vapor which then condenses back to liquid. If we distill ten gallons per minute, a pipe the size of the gasoline hose at a filling station will carry the condensed liquid but a large diameter pipe is needed to carry the 7,500 gallons per minute of vapor.

Presented at 64th NFPA Annual Meeting, Montreal, Quebec, May 16-20, 1960.

It is easy to design equipment to do this job. Knowing how much heat can be put into the still, we can readily calculate how big a vapor pipe is needed up to the condenser and how big a pipe is needed to carry the condensed product off to storage.

Having this worked out, let us now look for potential fire and explosion hazards. Perhaps the still is steam heated. Failure of a steam regulating valve could cause the liquid to distill two or three times as fast as normal. If, in such a situation, pressure is to be kept from increasing dangerously in the still, it can be done by making the pipes to and from the condenser large enough to do the job or the still can be designed to stand the higher pressure.

There is a greater potential hazard if the flow of cooling water or other coolant to the condenser stops, resulting in a large volume of vapor trying to flow through a pipe designed for a small flow of liquid. Such a condition with its attendant dangerous increase in pressure in the system, might be avoided by oversizing the condenser, the discharge pipe and the vent from the liquid receiver so that they could carry this vapor discharge in such an emergency. This is actually done in a few cases.

Another way in which overpressure in a still can be created is by plugging the vapor passage with a flood of liquid.

The conventionally accepted method of safeguarding a still against any of these potential hazards is to provide an adequately sized safety exit for vapor,

direct from the still to a safe location. In this method, the emergency vapor exit hardware usually consists of a relief valve, a rupture disc or, sometimes, a liquid seal. "How large is adequate?" must be determined by the conditions of each installation.

A few additional points should be made about distillation problems and their solution. Instead of getting rid of the vapor when a line plugs, the liquid could be dumped. However, this usually requires an expensive permanent installation that may never be used so it is not a common practice.

It is obvious that if the generation of vapor can be stopped there is no vapor to get rid of in an emergency. Dumping cold water in the still is a way of stopping vapor generation but care must be taken to use cold water from some source other than that which feeds the condenser to protect against the possible loss of both cooling water sources at once. Various other schemes have been devised to stop vaporization in an emergency such as automatic shut-off of the heat source or the introduction of refrigerant into coils in the vapor space.

Rules for Heat Input Processes

From this discussion of distillation, some general conclusions can be drawn about safe design practices that can be applied to all processes requiring input of heat.

Rule 1 is to think through the process completely. Imagine all the possible process upsets, within reason, and pick out the worst.

Then, provide emergency means to keep any process upset from becoming the forerunner of a disaster. This can be accomplished in one or more of the following ways:

1. Design the equipment to contain the maximum pressure to which it might accidentally be subjected.

2. Design an emergency route whereby the heat input into the equipment can be removed rapidly to a safe location.

3. Design an emergency system to stop the input of the heat into the equipment so that only the relatively small amount of heat trapped in the equipment needs to be vented or otherwise cared for.

Chemical Processes That Release Heat

Heat is one of the products of reaction of a large majority of chemical processes. When designing fire safety for these processes, one very important point must be kept in mind, namely, that an increase of 10°C (18°F) in the temperature of the reacting mixture usually about doubles the rate of the reaction and consequently doubles the rate of heat release. The designer who overlooks this point is a fool and the equipment he designs becomes a killer. Dr. E. D. Boynton,* Hercules Powder Company, has stated that no heat-producing reaction can be run safely in batch equipment if the equipment is designed to let the reaction proceed at a temperature more than 14°C above the temperature of the cooling medium.

Except for perhaps a little heat to start heat-producing reactions, external heat is not ordinarily used in this type of process. Usually the reaction starts as soon as the second reactant is added to the first. In fact, the temperature of the reaction is usually controlled as much by the rate at which the second ingredient is added as by the flow of coolant, and the more efficient the cool-

*How to Tame Dangerous Chemical Reactions, E. D. Boynton, W. B. Nichols and H. M. Spurlin. Industrial and Engineering Chemistry, Vol. 51, No. 4, April 1959.

ant the faster the second ingredient can be added.

As in heat input processes (e.g., distillations) coolants are thus an important factor in the safe operation of heat-producing reactions. The same design considerations apply: equipment strong enough to contain the maximum pressure to which it might be subjected, provision of emergency vents to remove heat and means of stopping heat input.

Example of Heat-Releasing Reaction

In heat-producing reactions, however, there are other upsets besides coolant failure that can cause trouble and many of these have potentially more serious results. As an example, consider the sulfonation of benzene, the nitration of benzene, or some other reaction of benzene with acid in a water-jacketed, stirred kettle. The usual procedure is to put the proper amount of acid in the kettle, start the stirrer, start the coolant, and then start the addition of benzene slowly. As the benzene is stirred into the mixture, it reacts, giving off heat, and the temperature rises to a sufficient temperature difference, but less than 14°C, between the reacting mixture and the coolant. This is a stable reaction troubling no one. In fact, even if the cooling water fails and the temperature rises, the amount of heat that must be vented is limited by the maximum rate at which the potential source of heat, in the form of benzene, can flow into the kettle. It can then readily be calculated that a vent only a few sizes larger than the benzene inlet pipe will be adequate to care for coolant failure.

Consider, however, the worst possible situation that could develop, namely, the reaction of large quantities of materials suddenly. This could occur if the stirrer stopped and benzene continued to flow. Benzene is not soluble in the acid and is much lighter, so it would float to the top and form a layer which would react slowly only at the interface between the two layers. If the condition is not discovered until a layer of benzene several inches deep has formed on top of the acid, the standard emergency procedure would be to shut off the flow of benzene, see that the stirrer is not started and to remove the benzene. Following this procedure, however, would depend upon someone's memory. Because of the notorious bad record of human memories in emergencies, a good process designer will foresee the possibility that under such conditions the stirrer might be started and he would, therefore, provide a vent line large enough to handle a large volume of vapors from boiling benzene. These vapors, of course, must be discharged where they cannot be ignited.

Alternate Safeguards

There are other ways, besides increasing vent size, to prevent pressure rupture of equipment in the stirrer-failure incident just cited. For example, the benzene feed line valve can be arranged to close automatically if the stirrer stops. This can be accomplished by an electric interlock between a solenoid valve and the current to the motor driving the stirrer. A more reliable device is a centrifugal switch on the stirrer shaft that automatically shuts the valve when the stirrer shaft stops. This arrangement does not, however, protect against the time when the stirrer drops off the shaft but the shaft keeps turning, so a still better means of stopping benzene if the stirrer fails is to control the valve by an ammeter on the stirrer motor.

Temperature-sensing devices arranged to shut off the flow of the reactant and to sound alarms can be used to control heat-releasing reactions but, as shown by the following excerpt from interoffice correspondence, their installation can be complex.

"Temperature recorders alone should not be depended upon for guidance in running an exothermic reaction, or a reaction in which heat sensitive materials are involved. Failure or misuse of the recorders, producing temperature indications lower than those which actually exist, make them an unreliable sole source of temperature indication for heat-sensitive processes.

"The exact type of temperature recording instrument to be used for checking reactions and the method of installation must be determined for each situation although there are certain guiding principles which should be considered in each case:

"1. The sensing element should be located in a separate well as close as is practicable to the well in which the sensing element of the temperature recorder is inserted.

"2. The dial, column, or other indicating device should be located for the most convenient continual observation of the operator.

"3. For each process to be conducted in the given equipment, model time-temperature charts should be prepared for the guidance of the operator so he will know what relationship should exist at any given time between the direct-reading instrument and the recorder pen.

"The best practice is to use thermocouples when measuring reaction temperatures, and not liquid or gas-pressure-actuated instruments where a slow leak in the bulb or the connecting tubing will cause a slow deviation downward of the recording or indicating needle of the instrument. For sensitive operations, a potentiometer is equipped with suitable over-temperature alarms, which are sometimes interlocked so that dump valves or cooling coils are actuated automatically. Thermocouple failure alarms are also made in similar manner. In most cases, a locally mounted industrial-type thermometer is provided at the reaction vessel in addition to the operating thermocouple. Whether a check instrument should be remotely located depends entirely upon the local conditions, operating procedures, and the nature of the operation itself. Sometimes it has been deemed advisable to install several thermocouples at various spots in the reaction area, where localized overheating may be a factor.

"On some hazardous batch reactions, one of the compulsory operating steps might be a quick check of the sensing element by immersion in boiling water, for example, to be sure the instrument is reasonably correct before each batch is begun. Of course, in many cases this may not be practical, so again each situation must be considered individually."

Hazards of Two-Phase Reactions

We have seen that in a simple distillation, loss of cooling water is the worst process upset; in a conventional stirred kettle reaction the sudden mixing of two liquid phases is the worst. What about the hazards associated with certain other two-phase reactions?

First, consider a gas reacting with a liquid or with a solid. Reactions like this are susceptible to ready control, generally by control of the flow of gas to the reactor except when the reaction is one of oxidation. Then, the flow of liquid or solid may be the controlling factor. In a case such as this the danger is that control failure may permit a dust cloud, or a vapor or mist cloud, to react explosively with the gas. The heat of the explosion can be dissipated safely by the use of rupture discs or, quite commonly, the equipment may be of heavy design to contain the explosion pres-

sure. The NFPA Explosion Venting Guide, No. 68, is very helpful in this type of design problem.*

In connection with solid-liquid reactions, a major problem is that coatings may form on the solid and that subsequent destruction of the coating may cause the reaction to run away and constitute the major upset for design purposes.

An example of the principal hazard of liquid-liquid reactions was the benzene-acid reaction previously discussed.

The following excerpt from an informal talk by Dr. Arthur Doering of American Cyanamid Company contains an excellent account of the dangers of solid-solid reactions.

"Reactions in the solid state are, of course, rarely attempted. There are, however, some very dangerous reactions that fall in this classification — notably those of explosive nature often resulting from contamination. All chemists must constantly be aware of combinations of powerful oxidizing agents and combustible materials, e.g., chlorates, chromates and peroxides with sulfur and charcoal and most organic compounds; similarly, very powerful reducing agents such as the alkali metals and metal hydrides react violently with many solid materials not generally considered oxidizing agents. Mixtures of powerful oxidizing and reducing agents should never be prepared unless the worker is seeking a rocket propellant or personal annihilation. Reactions of this type are frequently initiated by pressure and shock, a fact employed in the use of most explosives. An interesting safe demonstration of a solid-solid reaction is the formation of orange-red mercuric iodide by grinding dry, white mercuric chloride and potassium iodide. As with all reactions, heat is an important factor. Occasionally, contact with a catalytic agent induces change. A peculiar but not dangerous example of this effect is to be found in tin disease wherein hard metallic tin particles crumble to a gray dust on contact with a trace of the "infected" metal. This is particularly interesting in that it is a change favored by low temperatures."

*Published as a separate pamphlet and in National Fire Codes, Volume II.

Potentially Explosive Chemicals

These remarks of Dr. Doering lead into chemical processes that produce potentially explosive chemicals.

Diazo compounds are examples of potentially explosive compounds. When diazos are prepared and one of the components is diazotized, it has to be done in ice water because, as soon as it warms up, it decomposes.

What is proper protection for such reactions? Adequate vents cannot be designed so protection consists of providing all reaction controls possible and then surrounding the reaction equipment with a barricade.

Conclusion

Many methods are available for designing safety into chemical processes. Although this paper mentions several of these methods, the choice of the design features to be used in any one situation will depend on the details of the chemical process. No mention has been made of the importance of building construction and fire protection systems. Without proper consideration of construction and protection, no design for a safe chemical process is complete.

Keeping People Fire Conscious

By F. S. Staunton, Chief Fire Prevention Officer

Hamilton Fire Department, Hamilton, Ontario, Canada

Though Hamilton has no rigid, "premeditated" fire prevention program, a spontaneous, vigorous plan to keep people fire conscious is in full swing. This effort has obviously been successful as witnessed by the 1959 NFPA Fire Prevention Week Contest in which the Hamilton Fire Department was fortunate enough to place second among all entrants in Canada.

Shortly after the writer had taken over as Chief Fire Prevention Officer, he was confronted by certain questions put to him by representatives of an influential news medium in the city. Why were laws regarding fire prevention not taken so seriously as police laws, especially traffic laws? Should not the enforcement of fire codes be just as important as the enforcement of the police code? Apparently, upon investigation, these men could find no instance in recent months or years where a citizen of Hamilton had been brought before a magistrate for an infraction of the city fire ordinances. In their opinion the local fire prevention code was completely adequate.

Could it perhaps be possible that the people of Hamilton, though prone to breaking traffic laws and other police regulations frequently, for some particular reason were so conscious of fire regulations that they lived up to them implicitly?

Another matter brought up by these newsmen was the fact that it was almost unheard of to have an inquest regarding a fire death, of which there had been quite a number in recent years. On the other hand, a traffic or other violent death was practically always followed by an inquest for the purpose of establishing cause or possible negligence in order to avert a similar incident. Why was the same course not taken for a fire death? The only reason that could be given at that time for not having inquests of fire deaths was to protect the feelings of the relatives.

As a result of these questions and criticisms, a more definite program of enforcement of fire regulations was begun with the support of Chief Swanborough. A public relations officer was obtained to complete a better liaison with press and other news outlets. In this way it was hoped to get public recognition for the reasonableness and necessity of the requirements set forth in the ordinances.

The Housing Problem

The first problem to be solved had been brought about by the rapid population growth of Hamilton, an industrial city. Since its housing program could not adequately keep up with this growth, many large houses in the older residential sections had been converted into lodging and apartment houses and had become crowded with persons living in upper stories without proper means of egress and under other hazardous con-

Based on an address by the author at the 64th NFPA Annual Meeting held May 16–20, 1960, at Montreal, P. Q., Canada.

ditions. Many inspections had already been made of these places revealing these conditions, but only persuasion with very poor results had been tried to eliminate the hazards.

Legal notices were now sent to the most flagrant violators requiring elimination of these conditions within thirty days to avoid court action. Dwellings that were found through the assessment department to be overpopulated were investigated with a personal visit. Here also legal notices were sent out giving thirty days to eliminate any violation to a civic by-law. Existing requirements, concerning exits, almost parallel those of the NFPA Building Exits Code.

This program did not go without reactions. Many complaints were received from irate citizens and city councillors who believed these measures were too severe, so many cases had to be taken to court. Through the public relations officer, who was also an expert photographer, the public was kept well informed of the details of the cases by way of press, radio, and television. The reaction of the vast majority was very favorable.

One man, who protested to a magistrate that he would rather take his million dollars to Russia than erect a fire exit, was not only fined, but a court order was made out enabling the fire department to erect a fire escape and then charge the cost to his taxes. Another person, who ignored the requirements, after several appearances in court, had his business completely closed until the requirements were fully met. In this way property owners in general have been made more fire conscious.

School Fire Safety

The next step after making the property owners fire conscious was to look at the field of education and children. Since many of the schools were in a run-down condition and most of them were lacking in fire emergency training, it was decided to start at the top. Conferences were held with the local school boards, and men from the Fire Prevention Bureau were delegated to speak to home and school association meetings. The intended program was fully explained.

Elimination of hazards in school buildings such as open stairways and inadequate exits would be demanded. Though, like most school boards, they were in constant need of money, they decided if these improvements were necessary, money would have to be found.

A regular fire prevention program to be conducted by the Bureau as part of the school curriculum was also demanded. Even though their curriculum was crowded, this matter seemed so important, that a place would have to be found for it in the schedule. With these assurances, the Fire Chief went before the City Council and succeeded in having a man appointed to the Bureau with the rank of lieutenant and to be known as School Fire Safety Officer.

Since that time many thousands of dollars have been spent by the school boards for fire safety, and thousands of pupils have listened to lectures on fire prevention. As a result, the school boards and pupils of Hamilton are as fire conscious as any in Canada.

TV Station's Contribution

This led to many other activities in the juvenile field. Before a Boy Scout is eligible for his Queen's Scout Badge, it is necessary for him first to obtain a Fireman's Badge. The recognized course in the Hamilton area for obtaining this badge, and a similar one for Girl Guides,

is the one conducted under the supervision of our Bureau.

Local television station CHCH-TV was interested in having a slogan contest on its afternoon children's program conducted by Captain Andy. Since so much interest had of late been created by the Fire Department, the station management approached the Department as to the possibility of having a slogan contest based on fire prevention with members of the Bureau to act as judges. This was countered with a further proposal to allow each entrant to become also a Junior Fireman. Every fire hall in the city would become an application center. The Bureau would supply the stenographic staff for processing application forms, mailing literature and membership cards, and CHCH-TV would supply the publicity and the awards. This proposal was accepted and the Junior Fire Department was inaugurated.

Now Daily TV Program

During the contest, members of the Department appeared on the program each day demonstrating the use of various Fire Department tools and giving short safety talks. The response to the contest was so tremendous that both parties agreed it was too good to give up, and it was decided that the Fire Prevention Bureau would supply five minutes of material to the program each day from then on. School Fire Safety Officer Don Crooks became a regular member of the cast and is now known to thousands of children as Lieutenant Don. Junior Firemen who have managed some notable achievement in sports, school work, and even, in a few instances, bravery, have been interviewed on this show. It has been quite a thrill for these youngsters and their parents to realize that over 500,000 people were watching.

The response was terrific, in fact too big too handle. There were now 7,000 Junior Firemen, with over 2,000 of these from outside the city: 500 from the Toronto area alone, others from such centers as St. Catharines, Niagara Falls, Burlington, etc., and many from U. S. border towns. Invitations were sent to the fire chiefs of twenty-six nearby municipalities and townships, and through the courtesy of Mr. J. Arnott of Wilson and Cousins, a meeting was held in their offices. The Hamilton Fire Bureau and station CHCH-TV offered the aid of their experience and literature if the chiefs would care to start their own Junior Fire Departments. To date 22 replies of acceptance have been received, and these municipalities have applied for 37,000 membership cards. Within a short time it is expected that there will be about 50,000 Junior Firemen in Southern Ontario.

Fire Deaths Investigated

The query regarding inquests into fire deaths was never forgotten. With the cooperation of the Police Department, an Arson Squad was formed some two years ago. An inquest was demanded after every fire death. After the recent death of a five-year-old girl, active opposition came from certain quarters when an inquest was demanded. The following is an extract from a supporting editorial in our local newspaper:

"It is conceded that a decision whether or not an inquest should be held into a fatality can be difficult for Crown and police officials.

"The decision may involve balancing sympathetic consideration for the grief of survivors against the public benefit which could result from an open study of the circumstances by a coroner's jury of citizens.

"But this argument is often not brought to bear in traffic deaths; in the

case of railway crossing and all railway fatalities an inquest is required by law.

"When there are so many by-laws, regulations, and inspections directed against fire hazards in buildings, an inquest in which their application is openly discussed and emphasized by juries would serve to focus attention on them more urgently than is possible through such valuable but impersonal educational campaigns as the regular Fire Prevention Week."

Needless to say an inquest was held. The following is an extract from the same editorial page after the inquest:

"The statement of a fire department investigating officer that building and heating by-laws are being ignored by many people obviously is of great concern. If a jury's report can light the flame of public responsibility in this community — as it should do — then the inquest will have performed a vital service and Crown officials can take satisfaction in having done their duty.

"If stricter inspection standards are imposed, or more public care encouraged so that even one local fire is avoided — and possibly one life saved — then Tuesday's inquest will have been well worth the trouble, and the pain."

Perhaps most of our projects are routine to the daily experiences of many fire departments. This article is not meant to be a recitation of achievement, rather it is meant to stress these points: If there is a strong fire prevention code and the ability and willingness to enforce this code, coupled with an active public relations office, then there is no need to worry as to whether people are fire conscious. Our experiences prove that they will be.

Automatic Sprinkler Performance Tables

1960 Edition

The National Fire Protection Association presents herewith a summary of the performance of automatic sprinklers at fires reported to the Department of Fire Record. Similar performance tables have been published periodically, the most recent appearing in the April 1955 QUARTERLY.

These tables show the reliability of automatic sprinklers as a primary means of fire control and also point out those weaknesses in design or maintenance that can interfere with the effectiveness of sprinkler protection. The record of 96.2 per cent satisfactory performance (see Table 1) is a manifestation of the soundness of modern sprinkler standards and a tribute to the careful supervision by inspection departments, property owners, tenants and others responsible for the maintenance of sprinklers in operating condition at all times.

Since numerous fires, extinguished by one or two sprinklers, with a slight loss, are not reported to NFPA, the record represents only a fraction of the total number of fires in sprinklered properties. If it were possible to include a complete record, the efficiency of sprinkler performance shown by these tables would even more nearly approach 100 per cent.

The NFPA Fire Record files, maintained since 1897, include reports of 119,069 fires in sprinklered buildings. Of these, there were 18,834, or 15.8 per cent, in which sprinklers were not a factor because the fires were extinguished by other means before automatic sprinklers had an opportunity to operate. Of the remaining 100,235 fires, 32,778 occurred prior to 1925, and 67,457 in 1925–1959, inclusive. The accompanying tables summarize in detail the sprinkler experience of this latter 35-year period.

Table 2 shows the number of sprinklers operating on fires during 1925–1959. In this 35-year period, operation of not more than two sprinklers was required to control 55.3 per cent of the fires. Six or less sprinklers controlled 78.3 per cent of the fires. Table 2 also gives an indication of the comparative efficiency of wet and dry systems. In buildings where wet systems were installed 61.7 per cent of the fires were controlled by one or two sprinklers. The corresponding figure for dry systems was 34.5 per cent.

Effectiveness of sprinkler protection in 295 occupancies during the period 1925–1959 is given in Table 3. These

Table No. 1 — Summary of Sprinkler Performance

	Fires from 1897–1924 Inc.		Fires from 1925–1959 Inc	
	No.	Per Cent	No.	Per Cent
Practically or entirely extinguished	21843	66.7	38552	57.2
Held fire in check	9545	29.1	26351	39.0
Total Satisfactory	31388	95.8	64903	96.2
Unsatisfactory	1390	4.2	2554	3.8
Total	32778	100.0	67457	100.0

occupancies are grouped by classes — residential, assembly, educational, institutional, offices, mercantile, industrial, storage —,and include 35 occupancies reported individually for the first time. Among these new items are banks, dormitories, homes for aged, motels, museums, shopping centers, and supermarkets. For most of these the volume of sprinklered fire experience is very small and of no significance statistically. They are added to keep the record complete and to facilitate additions in future years.

Sprinkler performance by broad occupancy groups shows that mercantiles with 97.1 per cent efficiency have the best sprinkler performance record, whereas the storage occupancy record of 89.5 per cent was least satisfactory.

In these tables the designation "Extinguished fire" generally indicates cases where the automatic sprinklers extinguished the fire unaided. "Held in check" indicates cases where the sprinklers did not extinguish the fire but kept it under control pending its extinguishment by other means. A typical example of "Held in check" is the case where a fire starts under a table where water from sprinklers cannot reach it, but the sprinklers prevent any spread of fire beyond the table until someone puts

(*Continued, page 96*)

Table No. 2 — Number of Sprinklers Operating — Cumulative 1925–1959

No. of Sprinklers Operating	Wet Systems Per Cent	Dry Systems Per Cent	Type of System Not Given Per Cent	Total No. of Fires	Total Fires Per Cent
1	43.6	21.1	30.7	25049	38.1
2 or less	61.7	34.5	48.2	36494	55.3
3 or less	71.2	43.6	58.2	42590	64.6
4 or less	77.3	50.7	65.1	46734	70.9
5 or less	80.8	55.6	69.3	49406	75.0
6 or less	83.9	59.8	72.3	51620	78.3
7 or less	86.0	63.2	76.3	53190	80.7
8 or less	87.5	66.2	78.8	54539	82.7
9 or less	88.9	68.9	80.7	55554	84.3
10 or less	90.0	70.7	82.2	56446	85.7
11 or less	91.0	72.4	83.3	57151	86.7
12 or less	92.1	74.6	85.0	57978	87.9
13 or less	92.5	75.9	85.8	58478	88.7
14 or less	93.2	77.2	87.0	59037	89.6
15 or less	93.7	78.3	87.8	59491	90.2
16–20	95.6	82.7	90.9	61044	92.6
21–25	96.4	85.7	92.4	62001	94.2
26–30	97.2	87.8	93.7	62673	95.1
31–35	97.7	89.5	94.4	63149	95.7
36–40	98.1	90.2	95.3	63533	96.4
41–50	98.4	92.9	96.4	64048	97.1
51–75	99.0	95.2	97.7	64684	98.0
76–100	99.2	96.3	98.4	65010	98.7
Over 100	100.0	100.0	100.0	65937	100.0
No data*				1520	
Total Fires				67457	

*Includes 91 deluge systems that operated prior to 1954. Deluge systems performance subsequent to 1954 not recorded in this or other Tables.

Table No. 3. Sprinkler Performance Summary and Classification of Unsatisfactory Performance

Occupancy classes with a very small number of fires are not statistically significant and should not be used. They are included to keep the record complete and to facilitate additions in future years. A grand total of all occupancy classes with less than 25 fires individually show 91.9 per cent satisfactory performance.

	PERFORMANCE SUMMARY					CLASSIFICATION OF UNSATISFACTORY PERFORMANCE													
	Extinguished Fire Per Cent	Held Fire in Check Per Cent	Total Satisfactory Per Cent	Unsatisfactory Per Cent	Total No. of Fires	Water Shut Off	Partial Protection	Inadequate Water Supplies	System Frozen	Slow Operation	Defective Dry Pipe Valve	Faulty Building Construction	Obstruction to Distribution	Hazard of Occupancy	Exposure Fire	Inadequate Maintenance	Antiquated System	Miscellaneous and Unknown	Total
Residential Occupancies																			
Apartments (no mercantiles)	83.1	15.9	99.0	1.0	309	...	2	...	...	...	...	...	1	...	...	...	...	...	3
Apartments (with mercantiles)	64.4	32.1	96.5	3.5	56	1	...	...	...	...	...	...	...	1	...	...	...	...	2
Dormitories	33.3	16.7	50.0	50.0	6	...	...	2	...	...	...	1	...	...	...	...	...	...	3
Fraternity and sorority houses	0.0	100.0	100.0	0.0	1	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Hotels (seasonal)	71.0	20.4	91.4	8.6	93	3	...	...	1	...	...	2	...	...	...	1	1	...	8
Hotels (year round)	78.7	18.4	97.1	2.9	382	4	2	...	...	...	...	3	...	...	...	1	1	...	11
Motels	0.0	100.0	100.0	0.0	1	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Rooming Houses	73.9	17.4	91.3	8.7	23	1	1	...	...	...	...	...	...	...	...	...	...	...	2
Total (Residential)	78.0	18.7	96.7	3.3	870	9	5	2	1	...	...	6	1	1	...	2	2	...	29
Assembly Occupancies																			
Amusement places	64.1	28.1	92.2	7.8	64	4	...	...	...	...	...	...	...	...	...	1	...	...	5
Bowling alleys	76.4	16.3	92.7	7.3	55	2	1	...	...	...	...	1	...	...	...	...	...	...	4
Bus terminals	100.0	0.0	100.0	0.0	3	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Funeral parlors	100.0	0.0	100.0	0.0	1	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Churches	77.8	22.2	100.0	0.0	18	...	...	...	...	...	...	...	...	...	...	...	...	...	0
City clubs	79.3	19.2	98.5	1.5	68	1	...	...	...	...	...	...	...	...	...	...	...	...	1
Country clubs	69.1	25.5	94.6	5.4	110	2	2	1	...	...	...	...	...	...	...	1	...	...	6
Motion picture theatres	68.3	26.2	94.5	5.5	145	2	3	...	...	...	...	1	...	...	1	1	...	...	8
Museums	0.0	50.0	50.0	50.0	2	...	1	...	...	...	...	...	...	...	...	...	...	...	1
Night clubs	66.7	0.0	66.7	33.3	6	...	1	...	...	...	...	...	...	...	...	1	...	...	2

Table No. 3 (Continued)

	PERFORMANCE SUMMARY					CLASSIFICATION OF UNSATISFACTORY PERFORMANCE													
	Extinguished Fire	Held Fire in Check	Total Satisfactory	Unsatisfactory	Total No. of Fires	Water Shut Off	Partial Protection	Inadequate Water Supplies	System Frozen	Slow Operation	Defective Dry Pipe Valve	Faulty Building Construction	Obstruction to Distribution	Hazard of Occupancy	Exposure Fire	Inadequate Maintenance	Antiquated System	Miscellaneous and Unknown	Total
	Per Cent	Per Cent	Per Cent	Per Cent															
Assembly Occupancies (Continued)																			
Restaurants	69.3	29.8	99.1	0.9	541	2	...	...	...	...	...	3	...	...	...	...	...	...	5
Theatres	78.4	16.7	95.1	4.9	102	4	...	...	...	...	...	1	...	...	...	...	...	...	5
Total (Assembly)	70.8	25.9	96.7	3.3	1,115	17	8	1	...	...	...	6	...	...	1	4	...	...	37
Educational Occupancies																			
Colleges and universities	76.2	17.9	94.1	5.9	67	1	2	...	...	...	...	...	...	...	...	...	1	...	4
Private boarding schools	73.3	24.5	97.8	2.2	45	...	...	...	...	...	...	...	...	...	...	1	...	...	1
Public and parochial day schools	59.6	23.4	83.0	17.0	47	2	3	...	...	...	...	3	...	...	...	...	...	...	8
Trade schools	70.8	20.8	91.6	8.4	24	1	1	...	...	...	...	...	...	...	...	...	...	...	2
Total (Educational)	70.5	21.3	91.8	8.2	183	4	6	...	...	...	...	3	...	...	...	1	1	...	15
Institutional Occupancies																			
Homes for aged	77.0	7.7	84.7	15.3	13	...	1	1	...	...	...	...	...	...	...	...	...	...	2
Hospitals	73.7	23.3	97.0	3.0	133	2	...	...	...	...	...	1	...	...	...	...	1	...	4
Orphanages	0.0	100.0	100.0	0.0	1	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Prisons	54.2	37.5	91.7	8.3	24	...	...	1	...	...	...	...	...	1	...	...	...	...	2
Other institutions	80.5	14.6	95.1	4.9	41	1	1	...	...	...	...	...	...	...	...	...	...	...	2
Total (Institutional)	72.6	22.7	95.3	4.7	212	3	2	2	...	...	...	1	...	1	...	...	1	...	10
Office Occupancies																			
Banks	50.0	50.0	100.0	0.0	2	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Office buildings	77.7	20.3	98.0	2.0	295	3	1	...	...	...	...	...	...	1	...	...	1	...	6
Public buildings	72.9	16.2	89.1	10.9	37	...	1	1	...	...	1	...	...	...	...	1	...	...	4
Telephone exchanges	85.7	14.3	100.0	0.0	7	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Total (Offices)	77.2	19.9	97.1	2.9	341	3	2	1	...	...	1	...	...	1	...	1	1	...	10

Total (Offices)	77.2	19.9	97.1	2.9	341	3	2	1	...	...	1	...	...	1	...	1	1	...	10

Table No. 3 (Continued)

	PERFORMANCE SUMMARY					CLASSIFICATION OF UNSATISFACTORY PERFORMANCE													
	Extinguished Fire	Held Fire in Check	Total Satisfactory	Unsatisfactory	Total No. of Fires	Water Shut Off	Partial Protection	Inadequate Water Supplies	System Frozen	Slow Operation	Defective Dry Pipe Valve	Faulty Building Construction	Obstruction to Distribution	Hazard of Occupancy	Exposure Fire	Inadequate Maintenance	Antiquated System	Miscellaneous and Unknown	Total
	Per Cent	Per Cent	Per Cent	Per Cent															
Mercantile Occupancies																			
Department stores	77.3	20.1	97.4	2.6	1,102	15	3	1	...	...	1	4	3	...	...	1	1	...	29
Dry goods stores	82.0	15.6	97.6	2.4	370	7	...	...	...	...	...	2	...	...	...	...	...	...	9
Five cent to $1.00 stores	78.3	19.8	98.1	1.9	106	...	...	...	...	...	...	2	...	...	...	...	...	...	2
Furniture stores	71.3	24.1	95.4	4.6	271	8	...	...	...	...	...	3	1	...	...	1	...	...	13
Gasoline filling stations	71.4	28.6	100.0	0.0	7	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Grocery stores	76.4	20.8	97.2	2.8	284	3	1	...	...	1	...	2	...	1	...	...	...	...	8
Hardware stores	63.3	34.7	98.0	2.0	153	2	...	...	...	...	...	...	...	1	...	...	...	...	3
Mail order houses	82.7	17.3	100.0	0.0	52	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Motion picture exchanges	64.4	31.2	95.6	4.4	90	...	...	...	...	...	1	...	...	3	...	...	...	...	4
Multiple occupancy	69.5	26.8	96.3	3.7	1,397	19	2	3	4	1	2	13	3	4	...	...	...	1	52
Shoe stores	83.6	16.4	100.0	0.0	110	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Shopping centers	33.3	66.7	100.0	0.0	3	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Supermarkets	61.9	33.3	95.2	4.8	21	1	...	...	...	...	...	...	...	...	...	...	...	...	1
Wholesale mercantile	76.9	19.3	96.2	3.8	26	1	...	...	...	...	...	...	...	...	...	...	...	...	1
Other mercantiles	78.9	19.0	97.6	2.4	1,284	16	2	...	...	1	...	6	2	1	1	2	...	...	31
Total (Mercantile)	74.9	22.2	97.1	2.9	5,276	72	8	4	4	3	4	32	9	10	1	4	1	1	153
Industrial Occupancies																			
CHEMICALS AND CHEMICAL PRODUCTS																			
Asphalt	64.3	35.7	100.0	0.0	14	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Batteries	55.2	40.0	95.2	4.8	105	2	...	2	...	...	...	...	...	...	...	1	...	...	5
Candles	44.4	55.6	100.0	0.0	18	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Carbon	53.1	43.8	96.9	3.1	32	...	...	...	...	...	...	...	1	...	...	...	...	...	1
Cottonseed oil	28.0	37.0	65.0	35.0	57	5	...	7	...	...	...	...	...	2	1	1	3	1	20
Distilleries	43.3	45.4	88.7	11.3	53	...	...	...	...	...	...	...	...	5	...	...	1	...	6
Drugs	73.3	24.0	97.3	2.7	299	4	1	...	...	...	1	...	1	1	...	...	...	...	8
Fertilizer	47.7	42.8	90.5	9.5	21	...	...	...	...	...	...	...	...	2	...	...	...	...	2

Table No. 3 (Continued)

	PERFORMANCE SUMMARY					CLASSIFICATION OF UNSATISFACTORY PERFORMANCE													
	Extinguished Fire Per Cent	Held Fire in Check Per Cent	Total Satisfactory Per Cent	Unsatisfactory Per Cent	Total No. of Fires	Water Shut Off	Partial Protection	Inadequate Water Supplies	System Frozen	Slow Operation	Defective Dry Pipe Valve	Faulty Building Construction	Obstruction to Distribution	Hazard of Occupancy	Exposure Fire	Inadequate Maintenance	Antiquated System	Miscellaneous and Unknown	Total
Industrial Occupancies (Continued)																			
CHEMICALS AND CHEMICAL PRODUCTS (Continued)																			
Fireworks	33.3	44.5	77.8	22.2	9	...	...	...	...	...	...	...	...	2	...	...	...	...	2
Glue	26.3	63.2	89.5	10.5	19	1	...	...	...	...	...	...	...	1	...	...	...	...	2
Linseed oil	45.7	31.4	77.1	22.9	35	1	...	...	...	...	...	1	1	3	...	1	1	...	8
Matches	74.4	21.9	96.3	3.7	82	1	...	...	...	...	...	...	1	1	...	...	...	...	3
Munitions, powder	50.0	40.5	90.5	9.5	42	...	...	...	...	...	...	...	...	4	...	...	...	...	4
Paint and varnish	52.7	43.0	95.7	4.3	623	5	1	4	...	1	1	...	...	13	...	1	...	1	27
Plastics fabricating	44.4	53.2	97.6	2.4	126	1	2	...	...	...	...	...	...	...	...	...	...	...	3
Plastics mfg.	34.7	55.8	90.5	9.5	95	2	...	...	...	...	...	1	1	5	...	...	...	...	9
Pyroxylin fabricating	73.9	22.3	96.2	3.8	184	4	...	...	...	...	...	...	1	2	...	...	...	...	7
Pyroxylin mfg.	67.6	23.6	91.2	8.8	68	...	...	...	...	...	...	...	...	6	...	...	...	...	6
Pyroxylin reclaiming	54.7	33.7	88.4	11.6	86	...	...	...	...	...	...	...	...	9	1	...	...	...	10
Refineries, animal oil	55.0	30.0	85.0	15.0	20	...	1	...	...	...	...	...	...	2	...	...	...	...	3
Refineries, mineral oil	55.0	40.0	95.0	5.0	20	...	...	...	...	1	...	...	...	...	...	...	...	...	1
Refineries, vegetable oil	44.3	45.9	90.2	9.8	61	2	...	...	...	...	...	...	...	2	1	1	...	...	6
Roofing	25.0	69.5	94.5	5.5	308	2	1	3	...	...	...	...	4	3	...	2	...	2	17
Soap	54.3	40.4	94.7	5.3	94	3	1	...	...	...	...	...	...	...	1	...	...	...	5
Soybean processing	31.3	37.4	68.7	31.3	16	2	1	2	...	...	...	...	...	...	...	...	...	...	5
Synthetic fibers	43.1	51.6	94.7	5.3	188	3	...	1	...	...	...	...	2	1	...	1	...	2	10
Other chemicals	45.3	50.6	95.9	4.1	876	2	2	4	...	1	...	...	2	21	...	4	...	...	36
Total (Chemicals)	49.9	44.3	94.2	5.8	3,551	40	10	23	...	3	2	2	14	85	4	12	5	6	206
FIBER PRODUCTS																			
Brooms	81.9	13.6	95.5	4.5	44	1	...	1	...	...	...	...	...	...	...	...	...	...	2
Brushes	63.9	34.5	98.4	1.6	61	1	...	...	...	...	...	...	...	...	...	...	...	...	1
Rope	54.1	41.8	95.9	4.1	196	2	...	1	...	...	1	...	1	1	...	1	1	...	8
Other fiber products	33.7	59.9	93.6	6.4	187	2	...	1	1	...	1	...	4	2	...	1	...	...	12
Total (Fibers)	50.0	45.3	95.3	4.7	488	6	...	3	1	...	2	...	5	3	...	2	1	...	23

Table No. 3 (Continued)

	PERFORMANCE SUMMARY					CLASSIFICATION OF UNSATISFACTORY PERFORMANCE												
	Extinguished Fire	Held Fire in Check	Total Satisfactory	Unsatisfactory	Total No. of Fires	Water Shut Off	Partial Protection	Inadequate Water Supplies	System Frozen	Slow Operation	Defective Dry Pipe Valve	Faulty Building Construction	Obstruction to Distribution	Hazard of Occupancy	Exposure Fire	Inadequate Maintenance	Antiquated System	Miscellaneous and Unknown	Total
	Per Cent	Per Cent	Per Cent	Per Cent															
Industrial Occupancies (Continued)																			
FOOD PRODUCTS																			
Bakeries	60.7	36.7	97.4	2.6	466	4	...	...	...	...	...	1	4	2	...	1	...	...	12
Bottling plants	64.2	33.9	98.1	1.9	53	1	...	...	...	...	...	...	...	...	...	...	...	...	1
Breweries	44.9	55.1	100.0	0.0	49	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Candy	61.3	35.3	96.6	3.4	386	4	3	...	...	...	...	1	...	1	1	3	...	...	13
Canneries	58.0	36.0	94.0	6.0	50	1	...	1	...	...	...	1	...	...	...	...	...	...	3
Cereal	40.5	54.8	95.3	4.7	42	1	...	...	...	...	...	...	...	1	...	...	...	...	2
Coffee and spice	59.7	39.1	98.8	1.2	169	...	2	...	...	...	...	...	...	...	...	...	...	...	2
Dairies, creameries	55.0	40.0	95.0	5.0	40	1	...	...	...	...	...	...	...	...	...	1	...	...	2
Flour, grist mills	53.7	31.0	84.7	15.3	216	7	3	3	...	1	...	1	...	11	1	2	...	4	33
Fruit packing	62.5	37.5	100.0	0.0	24	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Gum	71.4	28.6	100.0	0.0	21	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Ice	50.0	37.5	87.5	12.5	8	...	...	...	...	...	...	1	...	...	...	...	...	...	1
Ice cream	52.9	47.1	100.0	0.0	17	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Macaroni	50.0	46.7	96.7	3.3	30	1	...	...	...	...	...	...	...	...	...	...	...	...	1
Meat packing	50.0	44.1	94.1	5.9	302	11	1	1	...	...	...	2	...	1	...	2	...	...	18
Peanut processing	32.1	46.5	78.6	21.4	28	3	...	...	...	1	...	...	...	...	2	...	...	...	6
Rice mills	31.6	42.1	73.7	26.3	19	1	...	1	...	...	...	...	1	...	...	...	1	1	5
Starch	54.6	40.9	95.5	4.5	22	...	...	...	...	...	...	...	...	1	...	...	...	...	1
Sugar	42.8	51.3	94.1	5.9	84	1	...	1	...	...	...	...	2	...	...	1	...	...	5
Other food products	50.3	48.7	99.0	1.0	207	...	...	...	...	...	...	...	1	1	...	...	...	...	2
Total (Food Products)	55.4	39.8	95.2	4.8	2,233	36	9	7	...	2	...	7	8	18	4	10	1	5	107
GLASS PRODUCTS																			
Incandescent lamps	59.1	40.9	100.0	0.0	22	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Mirrors	84.4	12.5	96.9	3.1	32	1	...	...	...	...	...	...	...	...	...	...	...	...	1

Table No. 3 (Continued)

	PERFORMANCE SUMMARY					CLASSIFICATION OF UNSATISFACTORY PERFORMANCE													
	Extinguished Fire Per Cent	Held Fire in Check Per Cent	Total Satisfactory Per Cent	Unsatisfactory Per Cent	Total No. of Fires	Water Shut Off	Partial Protection	Inadequate Water Supplies	System Frozen	Slow Operation	Defective Dry Pipe Valve	Faulty Building Construction	Obstruction to Distribution	Hazard of Occupancy	Exposure Fire	Inadequate Maintenance	Antiquated System	Miscellaneous and Unknown	Total
Industrial Occupancies (Continued)																			
GLASS PRODUCTS (Continued)																			
Optical works	60.5	39.5	100.0	0.0	109	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Other glass products	50.4	43.0	93.4	6.6	274	6	...	2	1	...	...	2	1	4	...	2	...	...	18
Total (Glass Products)	55.8	39.8	95.6	4.4	437	7	...	2	1	...	...	2	1	4	...	2	...	...	19
LEATHER, LEATHER PRODUCTS																			
Artificial leather	57.0	40.0	97.0	3.0	100	...	...	...	...	...	...	1	...	2	...	...	...	...	3
Bags, luggage	76.2	9.5	85.7	14.3	42	3	...	1	...	...	...	1	...	...	1	...	...	...	6
Glove leather tanneries	57.7	32.7	90.4	9.6	52	...	1	...	1	1	1	1	...	...	...	...	...	...	5
Patent leather	54.2	37.5	91.7	8.3	24	1	...	...	...	...	...	...	...	...	1	...	...	...	2
Shoes	71.4	25.7	97.1	2.9	1,302	12	3	...	1	1	1	3	5	3	1	5	3	1	39
Shoe accessories	66.7	25.0	91.7	8.3	120	5	1	...	1	...	...	...	...	1	...	...	2	...	10
Sole, belting leather tanneries	50.7	38.8	89.5	10.5	67	2	...	1	...	...	...	1	...	1	1	...	1	...	7
Upper leather tanneries	58.9	35.3	94.2	5.8	224	7	2	1	...	...	2	1	...	...	...	...	...	...	13
Other leather products	67.0	31.2	98.2	1.8	545	4	...	2	...	...	...	...	1	2	...	1	...	...	10
Other tanneries	37.6	52.0	89.6	10.4	77	5	...	1	...	...	...	...	...	...	...	1	...	1	8
Total (Leather)	66.7	29.3	96.0	4.0	2,553	39	7	6	3	2	4	8	6	9	4	7	6	2	103
METAL, METAL PRODUCTS																			
Aircraft assembling	21.5	78.5	100.0	0.0	61	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Aluminum casting	22.2	66.7	88.9	11.1	9	1	...	...	...	...	...	...	...	...	...	...	...	...	1
Aluminum fabricating	34.5	58.6	93.1	6.9	29	...	...	...	...	...	...	...	1	1	...	...	...	...	2
Aluminum milling	26.6	66.7	93.3	6.7	15	...	...	...	...	...	...	...	...	1	...	...	...	...	1
Aluminum refining	50.0	50.0	100.0	0.0	2	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Cameras, photo equip.	60.2	39.8	100.0	0.0	83	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Copper, tin, zinc casting	30.7	66.7	97.4	2.6	39	1	...	...	...	...	...	...	...	...	...	...	...	...	1
Copper, tin, zinc fabricating	35.1	61.9	97.0	3.0	168	2	1	1	...	...	...	1	...	...	...	...	...	...	5

Table No. 3 (Continued)

	PERFORMANCE SUMMARY					CLASSIFICATION OF UNSATISFACTORY PERFORMANCE													
	Extinguished Fire	Held Fire in Check	Total Satisfactory	Unsatisfactory	Total No. of Fires	Water Shut Off	Partial Protection	Inadequate Water Supplies	System Frozen	Slow Operation	Defective Dry Pipe Valve	Faulty Building Construction	Obstruction to Distribution	Hazard of Occupancy	Exposure Fire	Inadequate Maintenance	Antiquated System	Miscellaneous and Unknown	Total
	Per Cent	Per Cent	Per Cent	Per Cent															
Industrial Occupancies (Continued)																			
METAL, METAL PRODUCTS (Continued)																			
Copper, tin, zinc milling	33.3	66.7	100.0	0.0	12	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Copper, tin, zinc refining	14.3	85.7	100.0	0.0	7	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Electrical appliance assembling	55.4	42.2	97.6	2.4	1,459	11	3	2	...	3	1	2	7	3	...	2	1	...	35
Engine fabricating	35.7	64.3	100.0	0.0	70	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Engine test cells	0.0	87.5	87.5	12.5	8	...	...	...	...	...	...	...	1	...	...	...	...	...	1
Iron casting	34.4	62.2	96.6	3.4	320	6	...	...	1	...	...	1	1	2	...	...	...	...	11
Iron conversion	68.7	31.3	100.0	0.0	16	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Iron fabricating	37.4	60.6	98.0	2.0	246	1	...	...	...	...	1	1	...	1	...	1	...	...	5
Iron smelting	44.5	55.5	100.0	0.0	9	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Jewelry fabricating	59.1	39.2	98.3	1.7	296	3	...	...	...	...	1	...	...	1	...	...	...	...	5
Magnesium casting	44.4	44.4	88.8	11.2	9	...	...	...	...	...	...	...	...	1	...	...	...	...	1
Magnesium fabricating	30.8	69.2	100.0	0.0	13	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Magnesium refining	0.0	0.0	0.0	100.0	1	1	...	...	...	...	...	...	...	...	...	...	...	...	1
Metal machining	64.4	33.7	98.1	1.9	616	6	...	1	...	...	...	...	...	2	...	3	...	...	12
Metal plating	29.2	68.7	97.9	2.1	96	1	...	...	...	...	...	...	...	...	...	1	...	...	2
Mining property	67.5	22.5	90.0	10.0	40	4	...	...	...	...	...	...	...	...	...	...	...	...	4
Plumber's supplies	67.5	25.6	93.1	6.9	43	2	1	...	...	...	...	...	...	...	...	...	...	...	3
Steel casting	31.8	63.2	95.0	5.0	179	6	...	...	...	...	1	...	1	...	...	...	1	...	9
Steel fabricating	37.7	58.8	96.5	3.5	3,256	25	17	9	...	3	...	5	17	16	4	9	5	5	115
Steel forging	46.6	47.9	94.5	5.5	73	...	...	1	...	...	...	...	...	1	...	2	...	...	4
Steel rolling, stripping	56.2	41.1	97.3	2.7	219	1	...	...	...	...	1	...	1	1	1	1	...	...	6
Vehicle assembling	34.9	60.6	95.5	4.5	352	3	3	1	...	...	...	...	3	4	...	2	...	...	16
Wire fabricating	35.1	60.8	95.9	4.1	291	3	5	...	...	...	...	...	1	1	...	2	...	...	12
Other metals casting	30.0	70.0	100.0	0.0	10	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Other metals fabricating	38.2	59.7	97.9	2.1	144	...	2	...	...	...	...	...	...	1	...	...	...	...	3

Table No. 3 (Continued)

	PERFORMANCE SUMMARY					CLASSIFICATION OF UNSATISFACTORY PERFORMANCE												
	Extinguished Fire Per Cent	Held Fire in Check Per Cent	Total Satisfactory Per Cent	Unsatisfactory Per Cent	Total No. of Fires	Water Shut Off	Partial Protection	Inadequate Water Supplies	System Frozen	Slow Operation	Defective Dry Pipe Valve	Faulty Building Construction	Obstruction to Distribution	Hazard of Occupancy	Exposure Fire	Inadequate Maintenance	Antiquated System	Miscellaneous and Unknown	Total
Industrial Occupancies (Continued)																			
METAL, METAL PRODUCTS (Continued)																			
Other metals milling	100.0	0.0	100.0	0.0	2	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Other metals refining	25.0	66.7	91.7	8.3	12	...	...	...	...	...	...	...	...	...	1	...	...	...	1
Total (Metal)	43.8	53.1	96.9	3.1	8,205	77	32	15	1	6	5	10	33	36	6	23	7	5	256
MINERAL PRODUCTS																			
Abrasives	54.7	37.7	92.4	7.6	53	1	1	...	...	...	...	1	...	...	...	1	...	...	4
Asbestos	38.0	58.7	96.7	3.3	121	3	1	...	...	...	...	...	...	...	...	...	...	...	4
Brick, tile	37.0	59.3	96.3	3.7	27	...	...	...	...	...	...	...	...	...	...	...	1	...	1
Cement, plaster	67.8	25.8	93.6	6.4	31	1	1	...	...	...	...	...	...	...	...	...	...	...	2
Potteries	40.0	50.9	91.9	9.1	55	2	1	2	...	...	...	...	...	...	...	...	...	...	5
Stone	60.0	36.0	96.0	4.0	25	1	...	...	...	...	...	...	...	...	...	...	...	...	1
Total (Mineral)	45.8	48.7	94.5	5.5	312	8	4	2	...	...	...	1	...	...	...	1	1	...	17
PAPER, PAPER PRODUCTS																			
Bottle caps, seals	55.3	41.7	100.0	0.0	67	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Lamp shades	82.8	14.0	96.8	3.2	93	...	1	1	...	...	...	...	...	...	...	...	...	1	3
Paper coating	56.0	38.5	94.5	5.5	109	1	...	...	...	...	...	1	2	1	...	...	1	...	6
Paper mills	41.2	53.5	94.5	5.5	1,625	30	3	21	...	1	...	4	12	6	1	9	2	1	90
Wall paper	72.7	27.3	100.0	0.0	22	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Wastepaper, rag sorting	58.1	37.3	95.4	4.6	811	13	...	2	2	1	1	1	7	5	1	3	...	1	37
Other paper products	52.0	45.5	97.5	2.5	1,303	6	3	3	...	...	...	4	8	3	...	5	1	...	33
Total (Paper)	49.8	46.0	95.8	4.2	4,030	50	7	27	2	2	1	10	29	15	2	17	4	3	169
PRINTING, ENGRAVING																			
Engraving	86.8	13.2	100.0	0.0	99	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Printing	73.4	25.5	98.9	1.1	1,605	8	2	...	...	...	1	3	1	...	...	1	...	1	17
Total (Printing)	74.2	24.8	99.0	1.0	1,704	8	2	...	...	...	1	3	1	...	...	1	...	1	17

Total (Printing)	74.2	24.8	99.0	1.0	1,704	8	2	...	...	...	1	3	1	...	...	1	...	1	17

Table No. 3 (Continued)

	PERFORMANCE SUMMARY					CLASSIFICATION OF UNSATISFACTORY PERFORMANCE													
	Extinguished Fire	Held Fire in Check	Total Satisfactory	Unsatisfactory	Total No. of Fires	Water Shut Off	Partial Protection	Inadequate Water Supplies	System Frozen	Slow Operation	Defective Dry Pipe Valve	Faulty Building Construction	Obstruction to Distribution	Hazard of Occupancy	Exposure Fire	Inadequate Maintenance	Antiquated System	Miscellaneous and Unknown	Total
	Per Cent	Per Cent	Per Cent	Per Cent															
Industrial Occupancies (Continued)																			
RUBBER, RUBBER PRODUCTS																			
Rubber cloth	60.6	36.5	97.1	2.9	208	3	...	...	...	...	...	...	1	1	...	1	...	...	6
Rubber reclaiming	47.1	36.7	83.8	16.2	68	4	1	1	...	...	...	...	2	2	1	...	...	...	11
Synthetic rubber	0.0	100.0	100.0	0.0	5	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Tire recapping, repair	0.0	100.0	100.0	0.0	5	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Other rubber products	46.6	49.2	95.8	4.2	880	11	3	2	...	1	1	...	6	10	...	3	...	...	37
Total (Rubber)	48.7	46.7	95.4	4.6	1,166	18	4	3	...	1	1	...	9	13	1	4	...	...	54
TEXTILES, TEXTILE PRODUCTS																			
Artificial flowers, etc.	64.2	34.5	98.7	1.3	78	...	...	...	...	...	...	...	...	1	...	...	...	...	1
Bags	55.5	38.6	94.1	5.9	119	4	...	...	...	...	...	...	1	...	...	2	...	...	7
Braid	75.5	24.5	100.0	0.0	94	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Carpets, rugs	47.6	50.0	97.6	2.4	288	1	...	...	...	2	...	...	2	1	...	...	...	1	7
Clothing	74.7	24.2	98.9	1.1	2,615	11	3	4	...	...	...	3	2	...	2	3	...	1	29
Cotton gins	50.0	35.0	85.0	15.0	20	2	1	...	...	...	...	...	...	...	...	...	...	...	3
Cotton mills	56.8	42.3	99.1	0.9	10,068	31	3	6	...	2	1	1	8	8	...	23	2	5	90
Dyeing, bleaching, finishing	48.9	47.5	96.4	3.6	617	9	...	4	...	1	...	1	4	1	...	2	...	...	22
Fur products	75.9	21.1	96.9	3.1	359	3	...	2	...	2	...	...	2	...	...	...	1	1	11
Gloves	63.3	36.7	100.0	0.0	30	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Hair products	56.3	40.0	96.3	3.7	55	1	...	...	...	...	...	...	...	1	...	...	...	...	2
Hats	82.6	15.9	98.5	1.5	609	5	...	...	...	...	...	1	1	1	...	1	...	...	9
Knitting, full process	74.3	22.9	97.2	2.8	420	8	...	...	...	...	1	...	1	...	...	2	...	...	12
Knitting, part process	66.7	28.0	94.7	5.3	75	1	1	...	...	...	...	1	...	...	...	1	...	...	4
Linen mills	62.8	34.9	97.7	2.3	43	...	...	...	...	...	...	1	...	...	...	...	...	...	1
Linoleum	37.2	55.8	93.0	7.0	129	...	1	1	...	1	...	2	1	2	...	...	...	1	9
Mattresses	65.5	31.9	97.4	2.6	901	16	1	1	...	...	...	...	3	...	...	...	...	2	23
Oil cloth	55.3	44.7	100.0	0.0	38	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0

Table No. 3 (Continued)

	PERFORMANCE SUMMARY					CLASSIFICATION OF UNSATISFACTORY PERFORMANCE												
	Extinguished Fire Per Cent	Held Fire in Check Per Cent	Total Satisfactory Per Cent	Unsatisfactory Per Cent	Total No. of Fires	Water Shut Off	Partial Protection	Inadequate Water Supplies	System Frozen	Slow Operation	Defective Dry Pipe Valve	Faulty Building Construction	Obstruction to Distribution	Hazard of Occupancy	Exposure Fire	Inadequate Maintenance	Antiquated System	Miscellaneous and Unknown	Total
Industrial Occupancies (Continued)																			
TEXTILES, TEXTILE PRODUCTS (Continued)																			
Oil clothing	52.7	36.8	89.5	10.5	19	1	...	...	...	...	...	...	...	1	...	...	...	...	2
Shoddy mills	54.3	40.6	94.9	5.1	234	1	...	2	1	...	1	1	2	1	...	1	2	...	12
Silk mills	79.1	18.2	97.3	2.7	187	3	...	...	...	...	...	...	...	1	...	1	...	...	5
Umbrellas	75.8	21.2	97.0	3.0	33	...	...	...	...	...	...	...	...	1	...	...	...	...	1
Upholstering	50.0	48.8	98.8	1.2	86	...	...	...	...	...	...	...	...	1	...	...	...	...	1
Waste, batting mills	54.0	40.0	94.0	6.0	549	18	2	3	...	1	...	1	2	1	...	4	...	1	33
Weaving mills	74.5	24.2	98.6	1.4	588	3	...	1	...	...	...	...	3	...	...	1	...	...	8
Window shades	69.3	26.9	96.2	3.8	26	...	...	...	...	...	...	...	...	1	...	...	...	...	1
Wool scouring	59.3	31.3	90.6	9.4	64	1	...	2	...	...	...	1	1	...	...	...	1	...	6
Woolen mills	58.9	36.9	95.8	4.2	1,173	18	3	7	...	1	...	1	5	3	...	7	4	...	49
Worsted mills	75.0	22.8	97.8	2.2	92	...	1	...	...	...	...	...	...	...	...	1	...	...	2
Total (Textile)	54.3	43.9	98.2	1.8	19,609	137	16	33	1	10	3	14	38	25	2	49	10	12	350
WOOD PRODUCTS																			
Barrels	53.6	37.5	91.1	8.9	56	...	2	...	...	...	...	1	1	...	1	...	...	...	5
Boxes	50.5	37.8	88.3	11.7	265	10	2	6	1	1	1	1	...	4	1	2	2	...	31
Caskets	54.6	39.2	93.8	6.2	130	2	...	2	...	...	1	1	...	...	...	1	...	1	8
Cork	45.2	50.0	95.2	4.8	104	...	...	2	...	...	...	1	...	2	...	...	...	...	5
Excelsior	43.2	43.2	86.4	13.6	44	...	...	3	...	1	1	...	...	1	...	...	...	...	6
Furniture	58.2	34.2	92.4	7.6	1,733	44	13	20	1	3	7	8	3	23	1	4	2	2	131
Hardwood turning	51.2	38.6	89.8	10.2	303	9	1	4	...	...	...	5	1	4	1	4	1	1	31
Interior woodwork	51.0	36.5	87.5	12.5	345	12	4	9	1	3	1	2	3	5	...	2	1	...	43
Pails, woodenware	51.0	41.5	92.5	7.5	53	...	2	...	...	...	...	1	1	...	...	...	...	...	4
Picture frames	68.1	31.9	100.0	0.0	47	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Pulp mills	42.2	45.3	87.5	12.5	64	5	2	...	...	...	...	...	...	...	...	1	...	...	8

Pulp mills	42.2	45.3	87.5	12.5	64	5	2	...	...	...	...	...	...	...	...	1	...	...	8

Table No. 3 (Continued)

	PERFORMANCE SUMMARY					CLASSIFICATION OF UNSATISFACTORY PERFORMANCE												
	Extinguished Fire	Held Fire in Check	Total Satisfactory	Unsatisfactory	Total No. of Fires	Water Shut Off	Partial Protection	Inadequate Water Supplies	System Frozen	Slow Operation	Defective Dry Pipe Valve	Faulty Building Construction	Obstruction to Distribution	Hazard of Occupancy	Exposure Fire	Inadequate Maintenance	Antiquated System	Miscellaneous and Unknown	Total
	Per Cent	Per Cent	Per Cent	Per Cent															
Industrial Occupancies (Continued)																			
Wood Products (Continued)																			
Sash, doors, blinds	51.3	39.7	91.0	9.0	189	6	3	...	...	...	2	1	1	1	...	1	2	...	17
Saw, planing mills	33.7	35.0	68.7	31.3	246	17	15	12	2	4	1	1	4	14	2	2	2	1	77
Toys (wood and metal)	40.4	57.5	97.9	2.1	94	...	...	2	...	...	...	...	...	...	...	...	...	...	2
Wood heels and lasts	73.3	23.6	96.9	3.1	131	2	...	1	...	...	...	...	...	...	...	1	...	...	4
Wood flour	17.4	63.0	80.4	19.6	46	1	1	...	...	...	...	...	...	5	...	2	...	...	9
Other wood workers	54.2	40.7	94.9	5.1	628	11	1	6	...	1	...	1	2	5	2	1	2	...	32
Total (Wood)	53.4	37.4	90.8	9.2	4,478	119	46	67	5	13	14	23	16	64	8	21	12	5	413
Miscellaneous Industries																			
Auto paint shops	50.0	44.2	94.2	5.8	34	2	...	...	...	...	...	...	...	...	...	...	...	...	2
Button works	79.2	20.8	100.0	0.0	124	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Doll factories	52.2	47.8	100.0	0.0	180	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Dry cleaning plants	60.3	36.2	96.5	3.5	141	1	...	...	...	...	...	2	...	1	...	1	...	...	5
Electric light, power plants	56.5	30.4	86.9	13.1	23	3	...	...	...	...	...	...	...	...	...	...	...	...	3
Gas works	50.0	37.5	87.5	12.5	8	...	...	...	...	...	...	...	...	...	...	...	1	...	1
Junk shops	59.0	31.2	90.2	9.8	61	3	...	...	1	1	...	...	1	...	...	...	...	...	6
Laundries	61.7	34.9	96.6	3.4	572	9	2	1	...	...	...	2	...	1	...	2	1	...	18
Motion picture studios	71.0	25.8	96.8	3.2	124	1	1	...	...	...	...	...	...	2	...	...	...	...	4
Multiple occupancy mfg.	72.3	24.5	97.0	3.0	4,839	80	9	5	3	1	...	7	7	8	3	17	5	1	146
Paint shops	50.0	45.0	95.0	5.0	40	2	...	...	...	...	...	...	...	...	...	...	...	...	2
Radioactive materials labs.	100.0	0.0	100.0	0.0	1	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Radio, TV stations, studios	58.3	41.7	100.0	0.0	12	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Railroad repair shops	26.6	73.4	100.0	0.0	15	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Repair garages	67.4	30.3	97.7	2.3	1,147	13	1	2	2	...	1	2	1	3	...	1	...	...	26
Repair garages with sales	62.7	33.7	96.4	3.6	166	4	...	1	...	...	...	...	...	1	...	...	...	...	6
Scientific, research labs.	50.7	49.3	100.0	0.0	63	...	...	...	...	...	...	...	...	...	...	...	...	...	0

Table No. 3 (Continued)

	PERFORMANCE SUMMARY					CLASSIFICATION OF UNSATISFACTORY PERFORMANCE													
	Extinguished Fire Per Cent	Held Fire in Check Per Cent	Total Satisfactory Per Cent	Unsatisfactory Per Cent	Total No. of Fires	Water Shut Off	Partial Protection	Inadequate Water Supplies	System Frozen	Slow Operation	Defective Dry Pipe Valve	Faulty Building Construction	Obstruction to Distribution	Hazard of Occupancy	Exposure Fire	Inadequate Maintenance	Antiquated System	Miscellaneous and Unknown	Total
Industrial Occupancies (Continued)																			
MISCELLANEOUS INDUSTRIES (Continued)																			
Shipyards	50.0	39.1	89.1	10.9	64	3	...	4	...	...	...	...	...	...	...	...	...	...	7
Tobacco factories	52.5	44.7	97.2	2.8	143	1	...	1	...	...	...	1	...	...	...	1	...	...	4
Water works	50.0	50.0	100.0	0.0	2	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Miscellaneous mfg.	33.3	33.3	66.7	33.3	6	...	...	1	...	...	...	...	...	...	...	1	...	...	2
Total (Misc. Industries)	68.7	28.3	97.0	3.0	7,765	122	13	15	6	2	1	14	9	16	3	23	7	1	232
Total (Industrial)	55.1	41.4	96.5	3.5	56,531	667	150	203	20	41	34	94	169	288	34	172	54	40	1,966
Storage Occupancies																			
Aircraft hangars	50.0	50.0	100.0	0.0	22	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Builders' supplies	46.3	36.6	82.9	17.1	41	4	1	2	...	...	...	...	...	...	...	...	...	...	7
Car houses	45.8	48.5	94.3	5.7	35	...	1	...	...	...	...	...	...	...	...	1	...	...	2
Chemicals, drugs	48.5	45.5	94.0	6.0	33	...	...	...	...	...	...	...	1	1	...	...	...	...	2
Cold storage	70.4	15.9	86.3	13.7	44	2	...	...	1	...	1	...	...	2	...	...	...	...	6
Cotton	34.2	53.1	87.3	12.7	582	20	2	15	1	3	2	1	14	4	...	11	1	...	74
Electrical appliances, supplies	52.8	36.1	88.9	11.1	36	2	1	...	...	...	1	...	...	...	...	...	...	...	4
Fibers	25.9	48.2	74.1	25.9	27	1	...	...	...	...	...	...	4	1	...	1	...	...	7
Food products	65.4	27.4	92.8	7.2	139	5	1	1	...	...	1	...	...	1	...	...	...	1	10
Fur	0.0	100.0	100.0	0.0	1	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Furniture	60.0	34.0	94.0	6.0	150	4	...	...	...	...	1	...	1	1	1	1	...	...	9
General storage	64.0	28.6	92.6	7.4	122	1	...	2	...	...	1	1	1	1	1	...	1	...	9
Grain elevator — country	56.7	33.3	90.0	10.0	30	1	...	...	...	1	...	...	...	1	...	...	...	...	3
Grain elevator — terminal	53.3	22.3	75.6	24.4	45	2	...	1	...	...	...	...	...	6	...	...	2	...	11
Grain, feed, seed, hay	37.2	49.1	86.3	13.7	51	2	2	1	1	...	...	...	...	1	...	...	...	...	7
Hardware	45.9	40.6	86.5	13.5	37	2	1	...	...	...	...	1	1	...	...	...	...	...	5
Leather, leather products	75.2	23.8	100.0	0.0	21	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Liquor	33.3	50.0	83.3	16.7	24	2	...	...	...	...	...	1	...	1	...	...	...	...	4
Lumber	40.2	50.0	90.2	9.8	112	...	4	1	...	1	...	1	...	1	2	...	...	1	11

Liquor	33.3	50.0	83.3	16.7	24	2	...	...	...	...	...	1	...	1	...	...	...	...	4
Lumber	40.2	50.0	90.2	9.8	112	...	4	1	...	1	...	1	...	1	2	...	...	1	11

Table No. 3 (Continued)

	PERFORMANCE SUMMARY					CLASSIFICATION OF UNSATISFACTORY PERFORMANCE													
	Extinguished Fire	Held Fire in Check	Total Satisfactory	Unsatisfactory	Total No. of Fires	Water Shut Off	Partial Protection	Inadequate Water Supplies	System Frozen	Slow Operation	Defective Dry Pipe Valve	Faulty Building Construction	Obstruction to Distribution	Hazard of Occupancy	Exposure Fire	Inadequate Maintenance	Antiquated System	Miscellaneous and Unknown	Total
	Per Cent	Per Cent	Per Cent	Per Cent															
Storage Occupancies (Continued)																			
Mercantile stock	48.5	48.5	97.0	3.0	66	2	...	...	...	...	...	...	...	...	...	...	...	...	2
Metals	37.5	53.1	90.6	9.4	64	3	...	2	...	...	1	...	...	...	...	...	...	...	6
Multiple occupancy	58.1	19.3	77.4	22.6	62	6	2	1	1	...	...	1	1	1	...	1	...	...	14
Paper, paper products	51.3	38.0	89.3	10.7	150	5	1	...	...	...	1	...	2	1	...	6	...	...	16
Public household furniture	65.4	26.9	92.3	7.7	26	1	...	...	...	...	...	...	...	1	...	...	...	...	2
Parking garages	50.0	50.0	100.0	0.0	2	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Piers, wharves	52.3	38.6	90.9	9.1	88	2	3	...	...	...	...	...	...	2	1	...	...	...	8
Plastics, plastics products	0.0	50.0	50.0	50.0	2	1	...	...	...	...	...	...	...	...	...	...	...	...	1
Rubber, rubber products	48.0	36.0	84.0	16.0	25	1	...	1	...	...	...	1	...	...	...	1	...	...	4
Stables, barns	66.7	27.8	94.5	5.5	18	1	...	...	...	...	...	...	...	...	...	...	...	...	1
Terminal warehouse	52.7	40.9	93.6	6.4	110	3	...	...	...	...	...	...	2	1	1	...	...	...	7
Textiles	44.7	42.1	86.8	13.2	38	2	...	...	...	...	...	1	2	...	...	...	...	...	5
Tobacco	65.8	26.3	92.1	7.9	38	...	...	1	...	...	...	1	...	...	1	...	...	...	3
Waste	32.7	58.1	90.9	9.1	55	2	...	1	...	...	...	...	...	...	1	1	...	...	5
Wholesale groceries	46.8	43.8	90.6	9.4	32	2	...	...	...	...	...	...	1	...	...	...	...	...	3
Wood products	30.8	57.7	88.5	11.5	26	1	...	...	...	...	...	...	2	...	...	...	...	...	3
Wool	45.8	41.7	87.5	12.5	24	2	...	...	...	...	...	...	...	1	...	...	...	...	3
Other storage	57.1	34.2	91.3	8.7	219	10	1	2	...	...	...	1	3	...	1	1	...	...	19
Total (Storage)	48.4	41.1	89.5	10.5	2,597	92	20	31	4	5	9	10	35	28	9	24	4	2	273
Other Occupancies																			
Buildings under construction	40.0	33.3	73.3	26.7	15	3	...	...	...	...	...	...	...	...	...	...	...	1	4
Idle, vacant buildings	44.7	30.3	75.0	25.0	163	35	...	...	...	...	...	1	1	1	1	1	...	1	41
Miscellaneous other	66.3	23.3	89.6	10.4	154	7	...	...	...	...	...	1	...	4	...	2	1	1	16
Total (Other)	54.5	27.1	81.6	18.4	332	45	...	...	...	...	...	2	1	5	1	3	1	3	61
Total (All Occupancies)	**57.2**	**39.0**	**96.2**	**3.8**	**67,457**	**912**	**201**	**244**	**29**	**49**	**48**	**154**	**215**	**334**	**46**	**211**	**65**	**46**	**2,55**

the fire out with an extinguisher or small hose line. There are some slight variations in the reporting practices of different cooperating organizations, but these have no significant effect upon the tables.

Table 3 also lists the reasons for unsatisfactory sprinkler performance by occupancy. Closed sprinkler control valves continue to be the most frequent cause of unsatisfactory performance, being responsible for 36 per cent of all unsatisfactory performance reported. A detailed analysis of unsatisfactory sprinkler performance is given in Table 4.

It should be noted that these tables reflect only efficiency of operation, and are only indirectly related to the amount of fire losses. For example, where sprinklers do not operate because the water is shut off, unsatisfactory performance is recorded, even though the fire may have been promptly discovered and extinguished by normal means with small loss.

Grateful acknowledgment is made to the various organizations and individuals who have submitted the large volume of fire reports that permit this analysis.

Table No. 4 — Detailed Analysis of Unsatisfactory Sprinkler Performance

	Residential	Assembly	Educational	Institutional	Offices	Mercantile	Industrial	Storage	Miscellaneous Occupancies	Total
Water to Sprinklers shut off										
Valve defective or leaky	..	..	..	..	..	..	2	..	..	2
Unsupervised valve closed for undetermined reason	1	8	..	1	..	12	152	28	4	206
Premature shut off	1	2	1	..	..	10	167	17	7	205
Alterations or repairs to system	2	3	..	..	1	13	143	20	8	190
To prevent freezing	1	1	1	2	1	24	114	15	20	179
Cold weather valve closed out of season	..	1	..	..	..	5	23	2	..	31
To abet arson	1	..	2	..	..	5	27	6	2	43
Fear of water damage	..	..	..	..	1	..	18	1	..	20
Miscellaneous other reasons	3	2	..	..	..	3	18	3	4	33
Partial protection										
Originated in unsprinklered area	5	7	6	2	2	8	151	20	..	201
Spread to unsprinklered area	..	..	..	..	..	..	2	..	..	2
Inadequate water supply										
Insufficient water or low water pressure from public supply	1	1	..	..	..	2	98	14	..	116
Insufficient water or low water pressure from private supply	..	..	..	1	..	..	15	3	..	19
Insufficient water for both sprinklers and hose streams	1	1	..	..	1	..	42	9	..	54
Gravity tank empty	..	..	..	..	..	1	21	3	..	25
Pump failure or pump not started	..	..	..	1	..	..	12	..	..	13
Mains broken	..	..	..	..	..	1	8	1	..	10
Miscellaneous reasons	..	..	..	..	..	..	7	1	..	8
System frozen										
Pipes or valves frozen	1	..	..	..	..	4	20	4	..	29

Table No. 4 (Continued)

	Residential	Assembly	Educational	Institutional	Offices	Mercantile	Industrial	Storage	Miscellaneous Occupancies	Total
Slow operation										
Excessive heads on dry pipe valve	..	..	..	..	..	..	19	..	..	19
High temperature sprinklers	..	..	..	..	..	..	8	..	..	8
Failure of quick opening device	..	..	..	..	..	..	2	..	..	2
Heat actuating devices inadequate or inoperative	..	..	..	..	..	..	3	..	..	3
Miscellaneous reasons	..	..	..	..	..	3	9	5	..	17
Defective dry pipe valve										
Defective or improperly adjusted dry pipe valve	..	..	..	..	1	4	34	9	..	48
Faulty building construction										
Concealed horizontal or vertical spaces lacking protection	6	6	3	1	..	31	80	4	1	132
Floor or roof collapse	..	..	..	..	..	1	11	6	1	19
Miscellaneous deficiencies	..	..	..	..	..	..	3	..	..	3
Obstruction to distribution										
Fires under benches, etc.	..	..	..	..	..	1	90	5	..	96
High piling of stock	..	..	..	..	..	3	58	27	..	88
Partitions erected	1	..	..	..	..	4	12	2	1	20
Miscellaneous reasons	..	..	..	..	..	1	8	1	..	10
Hazard of occupancy										
Hazard too severe for sprinkler equipment as installed	..	..	..	..	..	6	154	16	3	179
Explosion damaged system	1	..	..	..	1	4	113	11	2	132
Water overflowed containers of flammable liquids	..	..	..	1	..	..	14	..	..	15
Miscellaneous reasons	..	..	..	..	..	..	7	1	..	8
Exposure fire										
Exposure fire overpowered sprinkler system in exposed building	..	1	..	..	..	1	35	9	1	47
Inadequate maintenance										
Plugged sprinklers	..	2	..	..	..	1	32	5	..	40
Sprinklers dirty, corroded or coated	..	..	..	..	..	1	34	2	2	39
Obstructed piping	2	2	1	..	..	2	98	17	1	123
Defective check valve	..	..	..	..	..	..	1	..	..	1
Miscellaneous reasons	..	..	..	..	1	..	7	..	..	8
Antiquated system										
Pipe sizes, sprinkler spacing sub-standard or old-standard	2	..	1	..	..	1	50	4	..	58
Valves sub-standard or old-standard	..	..	..	..	..	..	1	..	..	1
Sprinklers sub-standard or old-standard	..	..	..	..	1	..	2	..	1	4
Miscellaneous deficiencies due to age	..	..	..	..	..	..	1	..	..	1
Miscellaneous and unknown										
Causes of unsatisfactory sprinkler performance unknown or cannot be otherwise classified	..	..	..	1	..	1	40	2	3	47
Total	29	37	15	10	10	153	1966	273	61	2554

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From coast to coast, thousands of industrial, commercial and institutional establishments have discovered the *economy* of using ADT *automatic* protection to safeguard life, property, and profits against fire, burglary, holdup, sabotage and other hazards.

The leader in automatic property protection, ADT manufactures, installs, maintains and operates the most modern protection systems available anywhere. ADT electric and electronic systems are specifically designed to provide maximum security at lowest cost. Thousands of ADT subscribers enjoy substantial savings over other, less dependable and far more expensive methods of guarding their properties. At the same time, they are assured of the most reliable protection available.

ADT central stations are located in principal cities. In other areas, ADT systems may be connected directly to police and fire departments. These systems are fully maintained and regularly tested by ADT specialists.

For additional information, call our sales office in your city, listed in the Yellow Pages under *Burglar Alarms* or *Fire Alarms,* or write to our Executive Office.

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Controlled Companies of

AMERICAN DISTRICT TELEGRAPH COMPANY

Executive Office: 155 Sixth Avenue, New York 13, N. Y.

A NATIONWIDE ORGANIZATION

INCOMBUSTIBLE CEILING TILE
—*and they're ALL* by "CELOTEX"

Here are some examples of tile used in "Ceilings by Celotex" that meet building code requirements for incombustibility.

ALL ARE U.L. LISTED

FISSURED MINERAL FIBER TILE

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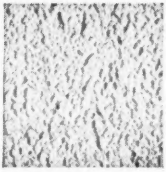
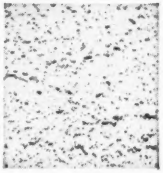
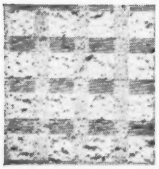


TEXTURE-TONE*

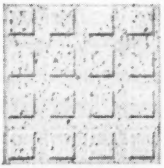


CELOTONE®

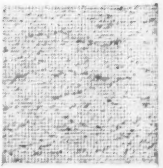


"DESIGN" CELOTONE® Plaid

"DESIGN" CELOTONE® Monarch

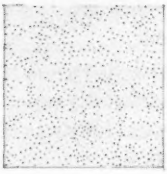


"DESIGN" CELOTONE® Empress



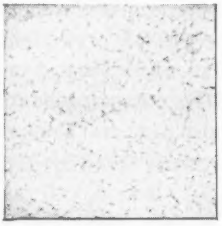
"DESIGN" CELOTONE® Modulo

PERFORATED MINERAL FIBER TILE



SERENE
Also available in Random Perforated Patterns and Standard Perforated Pattern.

GLASS FIBER PANELS



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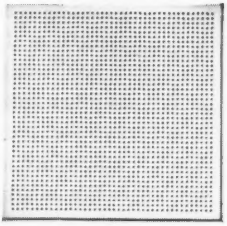
GYPSUM BOARD ASSEMBLY



CAVITY TILE†

*TRADE MARK

†U.S. PAT. NO. 2,838,808

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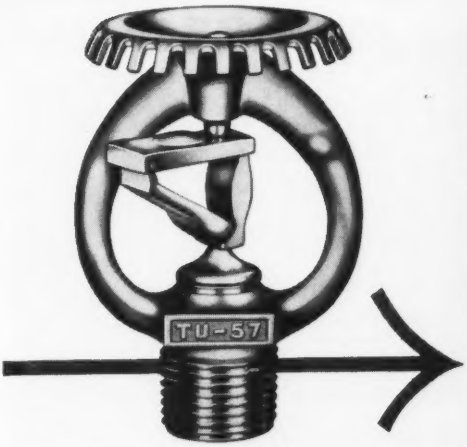
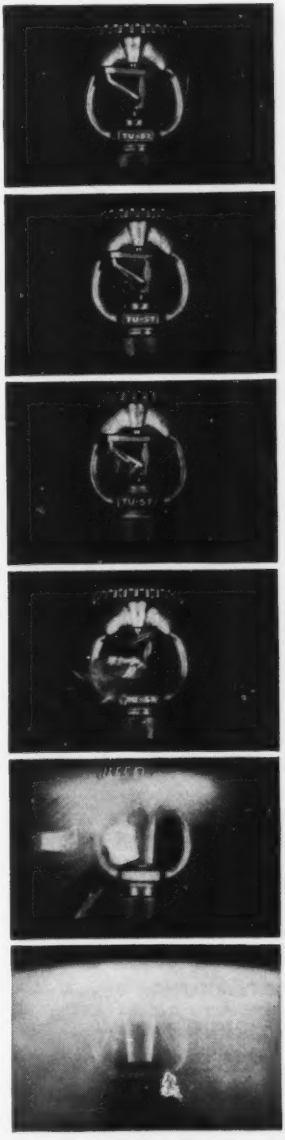


Protection

in one-tenth of a second!



The eye of the high-speed movie camera shows you what the human eye is not quick enough to see — the actual operation of the Rockwood WaterFOG Sprinkler Head. And it all happens in one-tenth of a second after the solder starts to melt. Then water sprays out to put out the fire fast.

Rockwood can engineer a complete fire protection system for you — a wet, dry pipe or Dualguard system. Whatever your special fire hazard problem, small or large, Rockwood can solve it!

Write for Rockwood's booklet, "Do You Have a Hidden Enemy in Your Plant?" It lists dangerous hazards and how to protect your plant from the fire losses they can cause. Tested and listed by Underwriters' Laboratories, Inc. Rockwood Sprinkler Division of The Gamewell Company. *A Subsidiary of E. W. Bliss Company.* **3001** Harlow Street, Worcester 5, Massachusetts.

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Engineers Water... to Cut Fire Losses

BLISS ROCKWOOD

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MODERN FIRE PROTECTION

Kinnear Rolling Fire Doors

This striking new high school at Kellogg, Idaho, presents architectural progress at its best. Right at home in this modern setting are six Kinnear Rolling Fire Doors, like the one at right — with the interlocking steel-slat curtain originated *by Kinnear* nearly 60 years ago. Like the school itself, these doors owe much of their eye appeal to basic, functional efficiency. In case of fire, they lower *automatically,* blocking the spread of flames. Positive, spring action starts them, yet downward speed is *controlled* for safety. And they can be opened after automatic closure, if necessary. For extra fire protection plus highest safety for building occupants install Kinnear "AKBAR" Rolling Fire Doors (labeled by Underwriters' Laboratories, Inc.)

For all regular (non-fire) needs, standard Kinnear Rolling Doors save space, time, and cut costs. They give added protection against fire, wind, weather, trespass, and vandalism. Built any size; motor or manual control.

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KINNEAR
ROLLING DOORS
Saving Ways in Doorways

CENTRAL STATION SIGNALS, INC.

Manufacturers of all kinds of approved devices used in Central Station Systems or Class 'A' or Class 'B' Proprietary Fire Alarm Systems, either automatic or manual.

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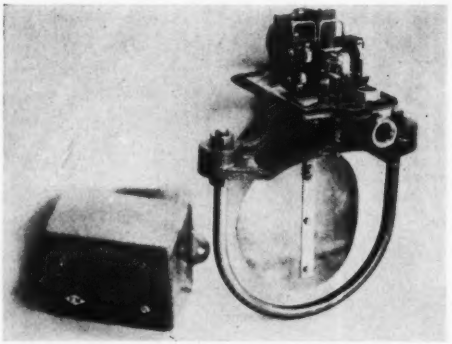

Model PRS-1

Sprinkler Waterflow Alarm

This device is approved by Factory Mutual Laboratories and Underwriters' Laboratories, Inc.

- This device is also made as Model PRT-1, a coded waterflow transmitter.

5-inch size shown above. To install simply drill 2-inch hole in pipe.

- Also made in explosion proof models.
- Made in all sizes from 2½" to 8".
- Has instantly recycling pneumatic retarding device, preventing false alarms.
- Has enclosed electrical contacts for any voltage not exceeding 15 amp. 125 volts, A.C. and ½ amp. 125 volts, D.C. Operates on all water pressures or surges.

Size is 1⅝" x ⅝"

Tempo-Set Model A Fire Detector

Underwriters' Laboratories, Inc. Approved.

- Self restoring and can be heat tested.
- Electrical contacts are silver or gold and are enclosed.
- Very reasonable price.
- Tempo-set Model A is approved in either open or closed circuit and the temperature ratings are 135 and 200 degrees.
- Approved maximum distance between thermostats on smooth ceilings: 20 feet.
- Electric ratings are 125 volts 1 ampere, A.C. or 24 volts 0.5 ampere D.C. or less.

CENTRAL STATION SIGNALS, INC.

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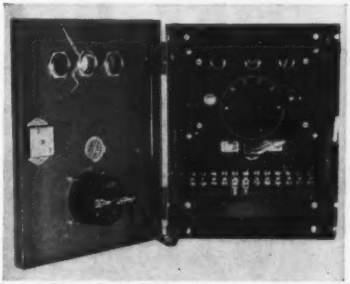
Proprietary & Remote Panels For Fire Headquarters

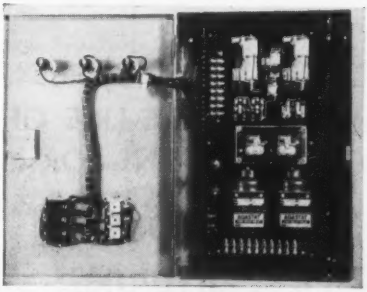
This Fire Headquarters Unit is designed to be used primarily for the receipt of signals at a remote station when actuated by a local alarm unit in the protected premises. It is electrically supervised and will give a trouble signal in case of open and ground and will also receive an alarm under these conditions. This panel is made for 12 or 24 volt D.C. operation.



Local Non-Coded Fire Headquarters Unit

Automatic McCulloh Class A Proprietary Panel

This single circuit panel is mounted in a red metal cabinet 18 x 12 x 6 inches, with switches and lights. This panel operates on the well known McCulloh principle. Signals are ordinarily received over a closed supervised circuit. With the McCulloh principle, a signal will be received over the circuit even though a single break or a single ground, or both, has occurred on the signaling circuit. This panel automatically adjusts the circuit for these fault conditions instead of the customary switches which are adjusted manually. A break or ground will be immediately indicated by a light and audible signal. The relays used in this panel are very sensitive and will receive signals from a considerable distance on No. 26 gauge wire and longer distances from heavier gauge wire. This panel operates on 24 or 48 volts of D.C. and requires a battery and rectifier for its operation.



Model ACP Single Circuit

Manual fire alarm boxes, automatic sprinkler alarm transmitters, automatic fire alarm, watchman supervisory signals, etc. can be received and recorded on this panel.

BOTH OF THE ABOVE PANELS ARE "APPROVED" BY UNDERWRITERS' LABORATORIES, INC.

HEADQUARTERS

for

FIRE DETECTORS

Listed by Underwriters' Laboratories, Inc.

All temperature ratings in either combination rate of rise and fixed point or fixed point operation only.

PANELS and BELLS

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Return loop panels that will sound a fire alarm even with a break, or other trouble, on the wiring circuit.

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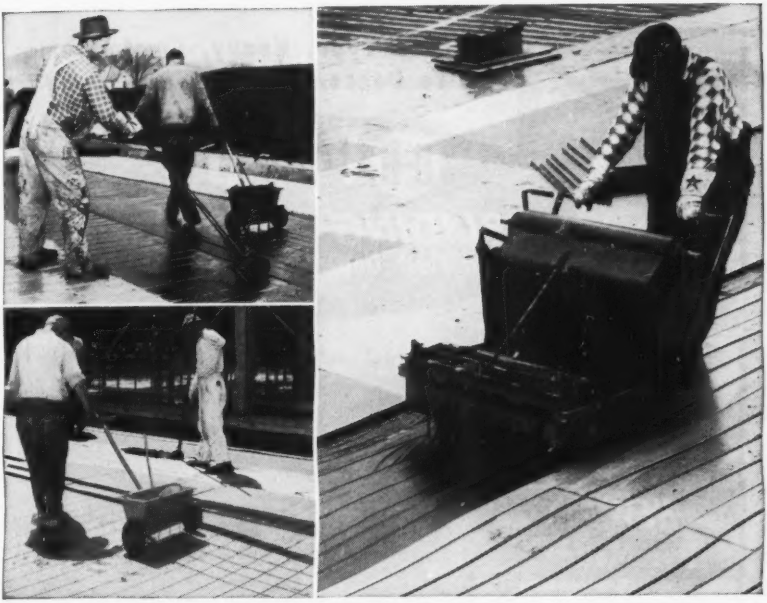

Pictures. (Right.) Lexsuco Applicator applies vapor barrier and adhesive for large jobs in a 3 in 1 operation. (Top left.) For smaller jobs, the semi-mechanical method is used to apply vapor barrier and adhesive with Spreader and Roller Coater. (Bottom left.) Lexsuco Spreader applies adhesive to secure insulation.

LEXSUCO
ROOF CONSTRUCTIONS

Engineered Applications Save Time and Money

LEXSUCO'S engineered application methods cut labor costs and speed up work in applying Lexsuco Fire-Retardant Roof Constructions on large or small jobs. Lexsuco products are reliable and job proven.

Remember, with or without a vapor barrier, Lexsuco Roof Constructions provide assured fire protection as tested and accepted by Factory Mutual Engineering Division and Underwriters' Laboratories, Inc. Write us for complete information or call your Lexsuco Representative.

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- More for Your Roofing Dollar
- Lower Insurance Premiums
- Engineered Application
- Better Roof Construction

LEXSUCO INC

BOX 336 • SOLON, OHIO

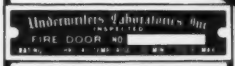
Pioneers in Fire-Resistant Roof Constructions

Old Type, Heavy, Cumbersome Fire Doors, Now Out-Moded by

D-H PyroDor®

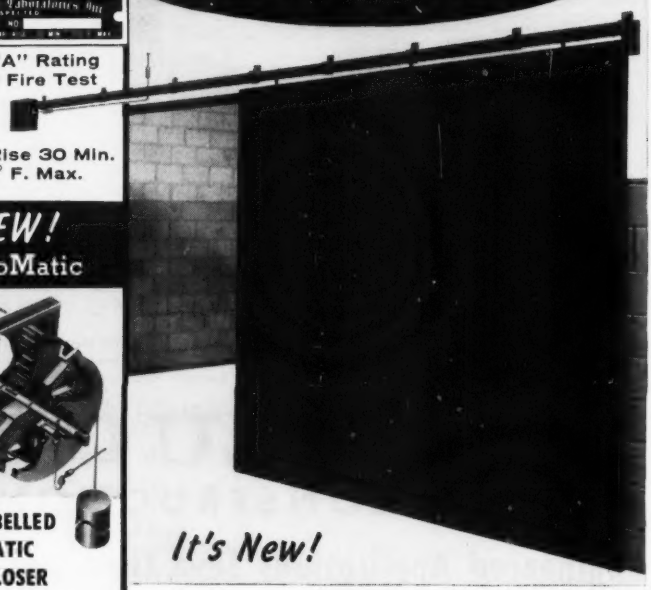
SLIDING FIRE DOOR

New Flush Design - New Forward Look



Class "A" Rating
3 Hour Fire Test

Temp. Rise 30 Min.
250° F. Max.



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PyroMatic

UL LABELLED
AUTOMATIC
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THE MOST COMPLETE LINE
OF FLUSH DOORS
STEEL • ALUMINUM
VINYL-ON-STEEL • WOOD

DUSING and HUNT, Inc.

Over 50 Years Manufacturing
Fireproof Doors and Metal Trim

67 LAKE STREET LE ROY, N. Y.

Good fire protection is a worthwhile investment at any price. However, it is only good business to get the best equipment at the most realistic cost. This is where Viking can be of great service to you.

VIKING

OFFERS THE BEST IN FIRE PROTECTION

from the ground up

For plant, office or warehouse; an automatic sprinkler system to meet every requirement — Wet, Dry-Pipe, Deluge or Pre-action. Engineered, manufactured and installed by fire protection experts. Pays for itself in reduced insurance costs.

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HASTINGS, MICHIGAN

NEW!

2½-lb. Pressurized Dry Chemical

5-lb. Pressurized Dry Chemical

Kidde dry chemicals kill more fire faster

Granted top rating by Underwriters' Laboratories, these two new Kidde extinguishers pack an extra punch, put out as much fire as eight and sixteen one quart CTC portables respectively. Perfectly balanced, light in weight, easy to operate, no pin to remove, no valves to turn, no inverting or bumping needed. Just aim and press lever! No pressure cartridge needed. Write for more information on these new Kidde extinguishers – easiest-to-operate dry chemical portables on the market today!

Kidde (K Kidde)

Walter Kidde & Company, Inc.
751 Main St., Belleville 9, N. J.
Walter Kidde & Company of Canada Ltd.
Montreal—Toronto—Vancouver

What is the function of Armstrong Acoustical Fire Guard Tile in a time-design-rated assembly?

Armstrong Acoustical Fire Guard is the first time-design-rated acoustical ceiling tile. It has been tested in a number of different floor-ceiling assemblies. Both the tile and the assemblies have received time-design ratings from Underwriters' Laboratories, Inc., of one to four hours.

To earn a rating, the acoustical tile and its floor-ceiling assembly must do two things. First, they must resist the passage of heat. This is a function of the entire assembly—the tile, the concrete slab, the air space in the plenum chamber, and the structural steel supporting the slab.

Second, the floor-ceiling assembly must support a maximum load. This depends upon the structural steel supports. If they buckle, the assembly will cave in. The protection of these steel members is the function of the acoustical tile, and the acoustical tile alone. Only the tile stands between the intense heat and the structural steel.

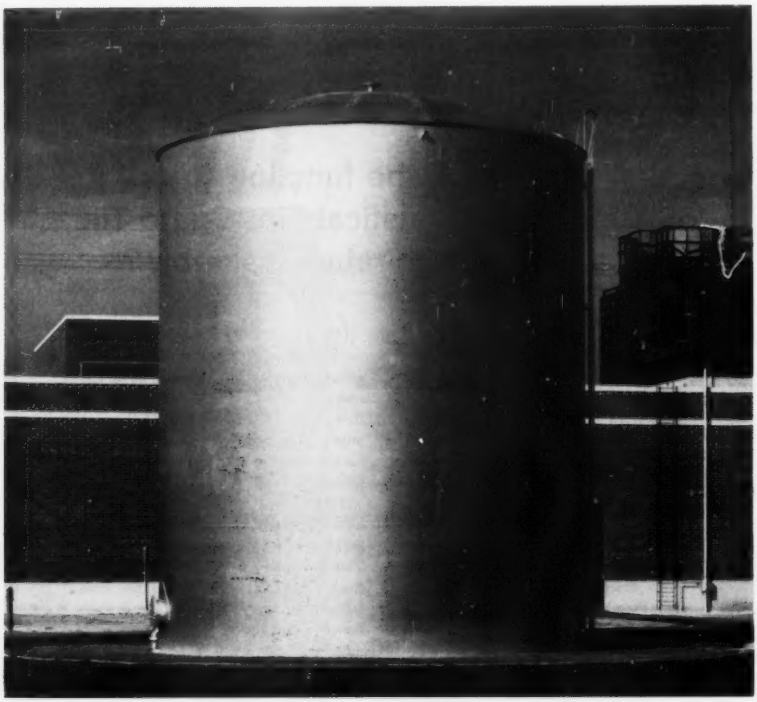
Official assembly hourly ratings are established when the assembly fails on either count. Structural failure never has ended a test on Armstrong Acoustical Fire Guard. (This, in spite of the fact *unprotected* open web steel joists have buckled in the test chamber in seven minutes.)

Tests on Acoustical Fire Guard always have been terminated because of temperature rise above the entire assembly. This factor could be improved with a thicker concrete slab. Variations from tested assemblies which will improve the fire-retardant rating obviously are permissible.

Before you specify your next ceiling, consider Armstrong Acoustical Fire Guard. It will help you give your client a safer building—often at a savings in cost. For more information, contact your Armstrong acoustical contractor or your nearest Armstrong district office. Or write to Armstrong Cork Company, 4207 Woodbridge Street, Lancaster, Penna.

Armstrong ACOUSTICAL CEILINGS

1860-1960 Beginning our second century of progress



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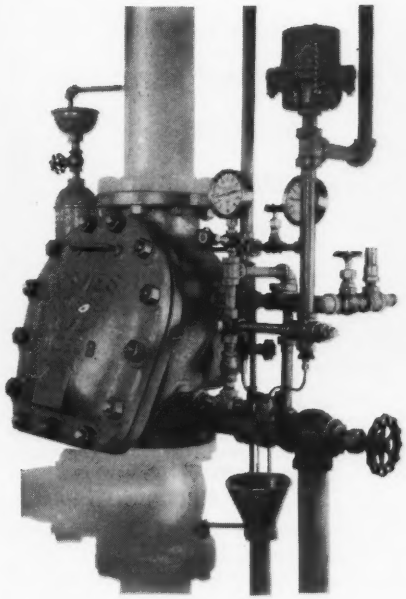

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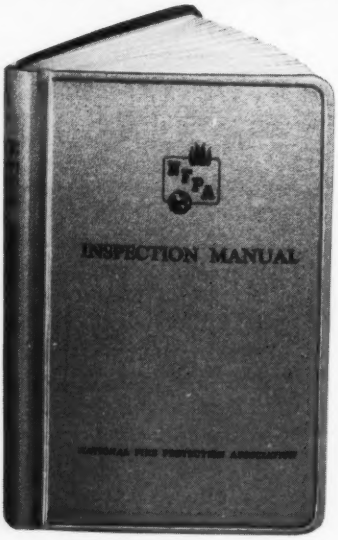

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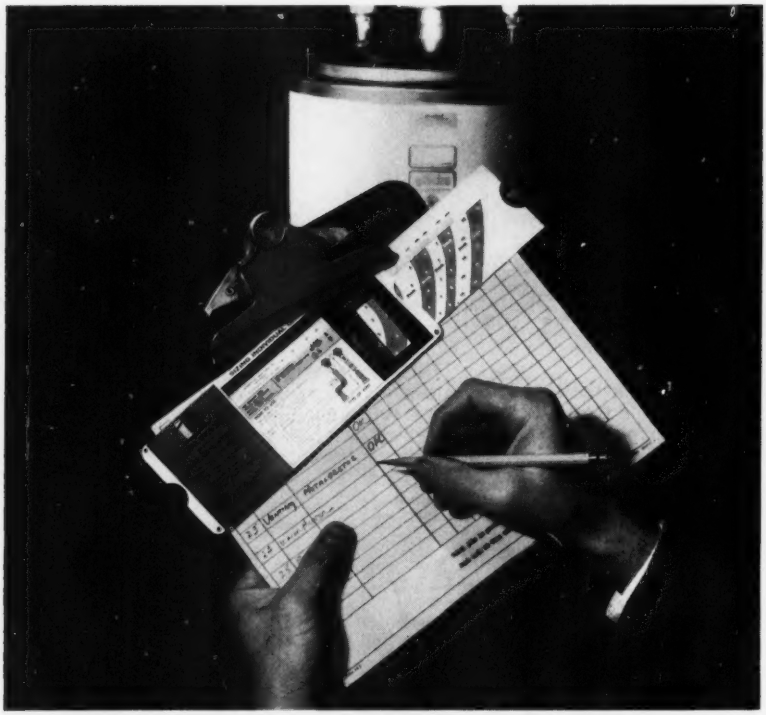

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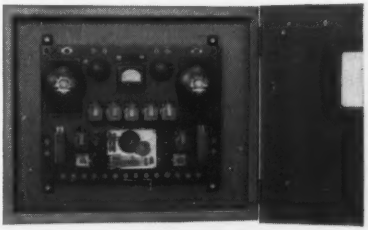

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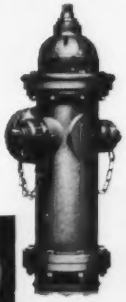

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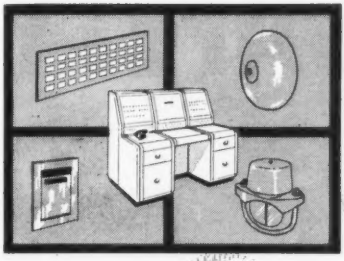

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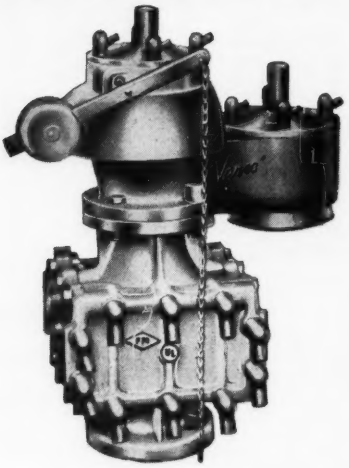
in combination with your VENT VALVES



Flame Arrester Unit listed by UNDERWRITERS' LABORATORIES Approved by Associated Factory Mutuals Laboratories and other governing agencies.

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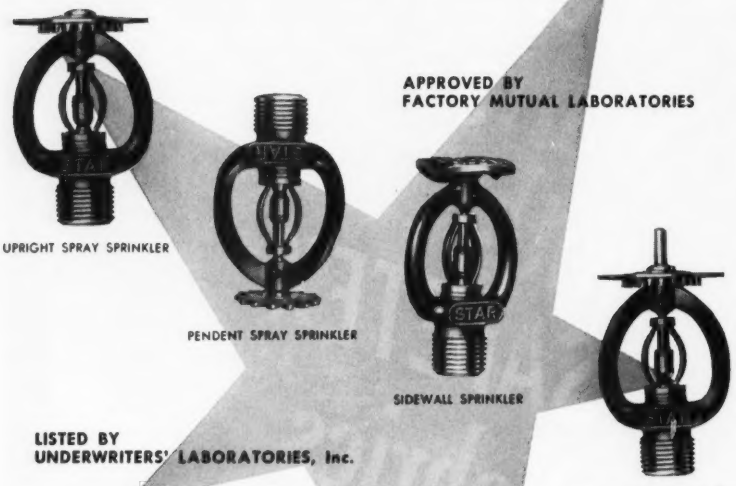

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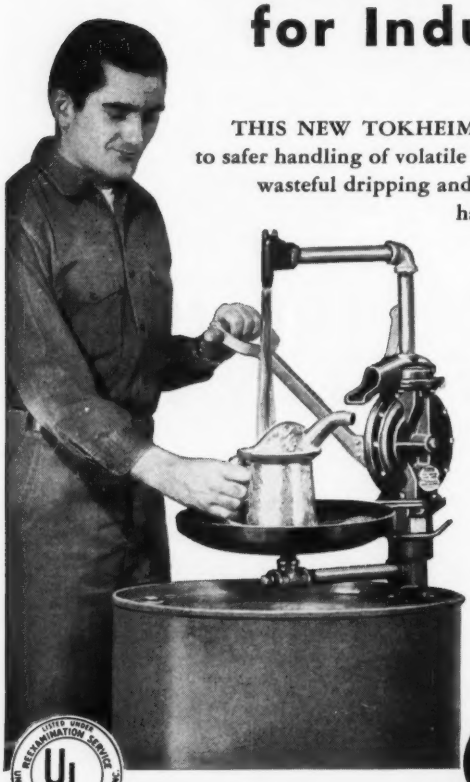

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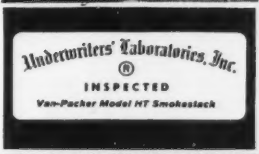

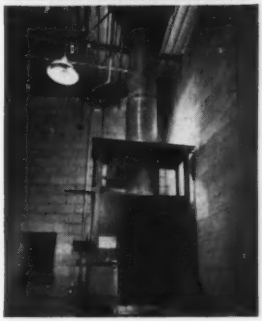

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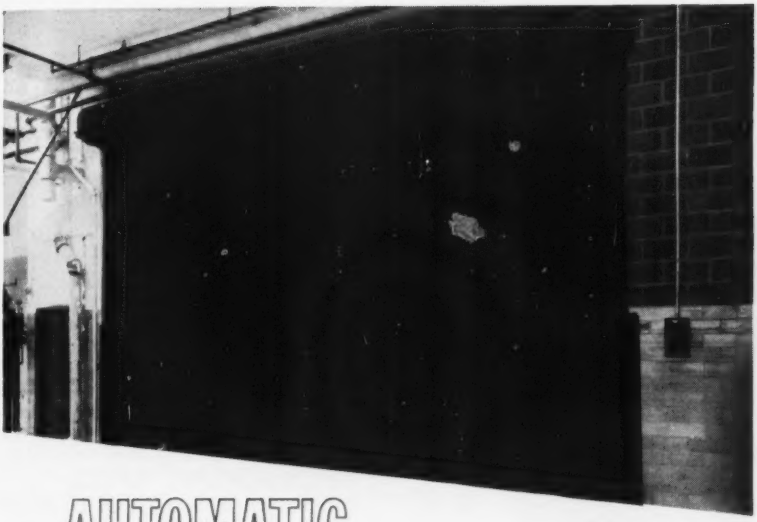

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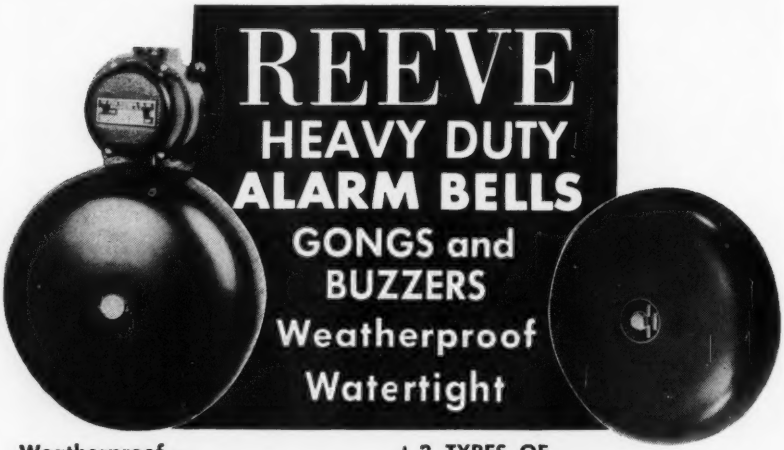

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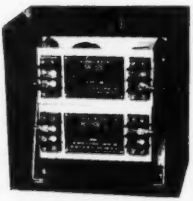

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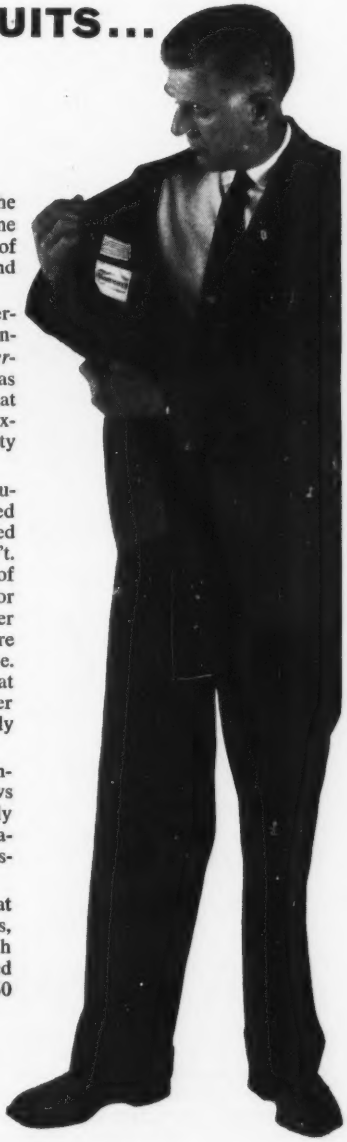
FIRE DOORS OR SUITS...

it pays to look for the label!



Would you buy a suit without looking at the label? Of course you wouldn't. As everyone knows, the label on your suit is an indication of the manufacturer's reputation for quality and workmanship.

For the fire protection specialist, the Underwriters' Laboratory label on a fire door guarantees quality and workmanship *plus proven performance*. It means the manufacturer's door has been fire tested and labeled by U/L, and that future labeled doors produced by him will be examined in his plant to guarantee identical quality standards with those fire tested.

When the U/L inspector visits the door manufacturing plant, he'll make certain that labeled doors are mortised and reinforced for a listed lock—they should not be labeled if they aren't. He'll be certain that the glass size and depth of setting in door lights meet U/L requirements for fire resistance. Louvers in fire doors are never approved by a U/L inspector—no louvered fire door has been successfully U/L tested to date. If a door has a fire-exit device, he'll require that it has a supplementary label, to assure the owner that it was factory installed and successfully tested for life safety as well as fire resistance.

One of the practices he won't approve is defining a door as "labeled construction"—he knows that the term "labeled construction" actually means *not labeled,* probably because some feature of the door has not or could not be successfully tested.

So when you buy doors, be sure and look at the label. And when looking at labeled fire doors, you'll want to talk to Overly—the company with the largest selection of U/L tested and labeled fire doors available today. Send for the 1960 Overly Fire Doorater for complete data.

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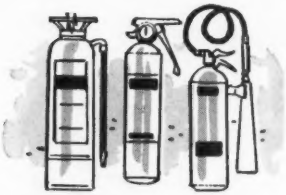
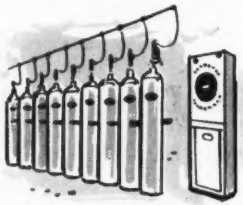
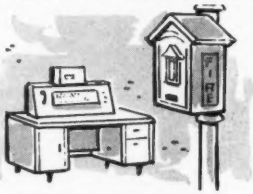


Fyr-Fyter, Pyrene-C-O-Two Buffalo fire extinguishers

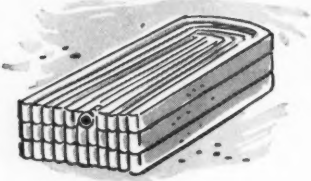


C-O-Two carbon dioxide, dry chemical, foam systems

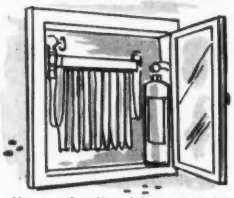
Globe sprinkler systems



Fyr-Fyter fire alarm systems



Municipal, industrial fire hose



Hose and extinguisher cabinets

Wooster brass fire equipment

Fire department supplies

complete fire protection from Fyr-Fyter

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To contact the representative nearest you, look in the yellow pages under "Fire Protection Equipment" or write to: The Fyr-Fyter Company, 221 Crane Street, Dayton 1, Ohio.

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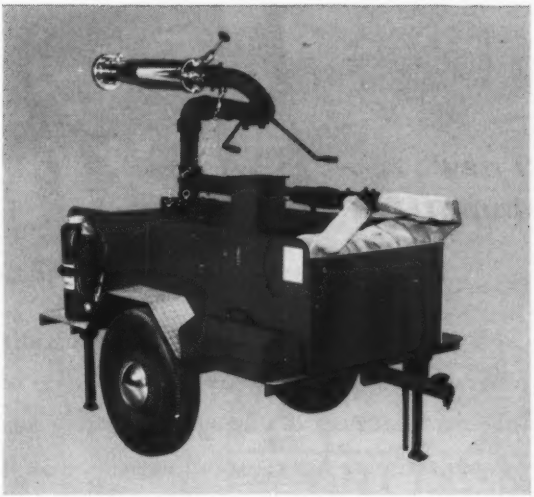

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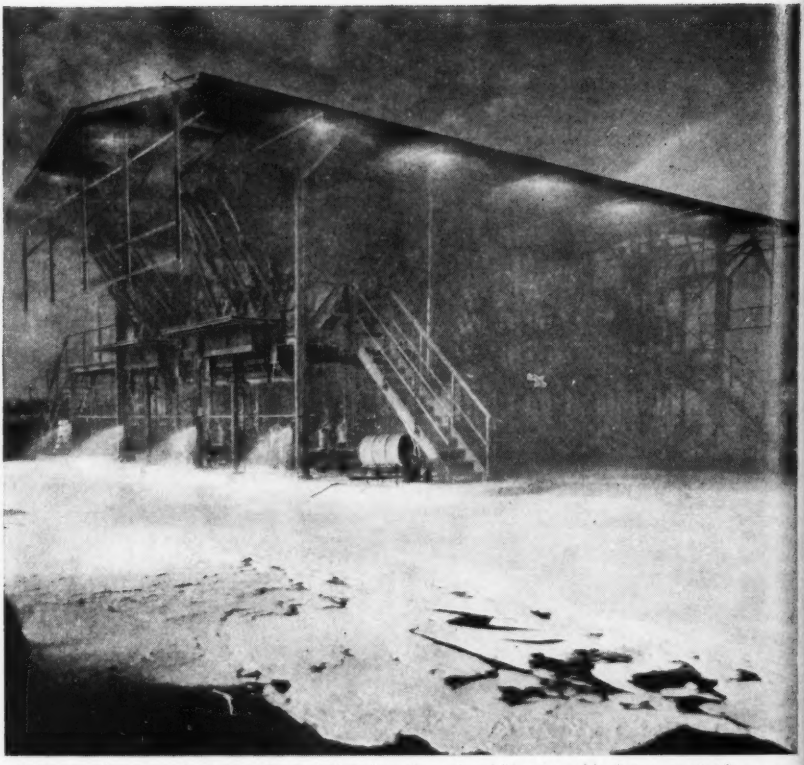

2 minutes after start of system under test. Note how fire-extinguishing foam blankets potential fire area.

This test shows how Grinnell's Spray-Foam System protects hazardous fire areas

In the dramatic illustration shown above, you see a Grinnell Spray-Foam System under test at a truck loading terminal in Detroit, Michigan. This fire-quenching foam system, designed for hazardous areas, is especially recommended for quelling blazes in petroleum base products, such as in gasoline, kerosene and fuel oil. Grinnell Systems are effective in controlling fires in chemicals, alcohols, benzol, solvents, paints and liquid gas.

For information about Grinnell Fire Protection Systems . . . and a Quick Selector Chart to help determine the most economical system for your fire hazard, write for Grinnell's 44-page manual "Special Hazard Fire Protection." No obligation. Write Grinnell Company, 227 West Exchange Street, Providence 1, Rhode Island.

Grinnell Fire Protection Systems include:

- Automatic Spray Sprinkler Systems: wet pipe, dry pipe, deluge and Simplex*
- Water Spray Systems with regular or Selfcon* (self-contained) water supplies; Multitrol* or Multimatic* valve; ProtectoSpray* nozzles or Mulsifyre* projectors
- ProtectoFoam* systems, producing mechanical foam
- Carbon dioxide systems
- Dry chemical systems

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